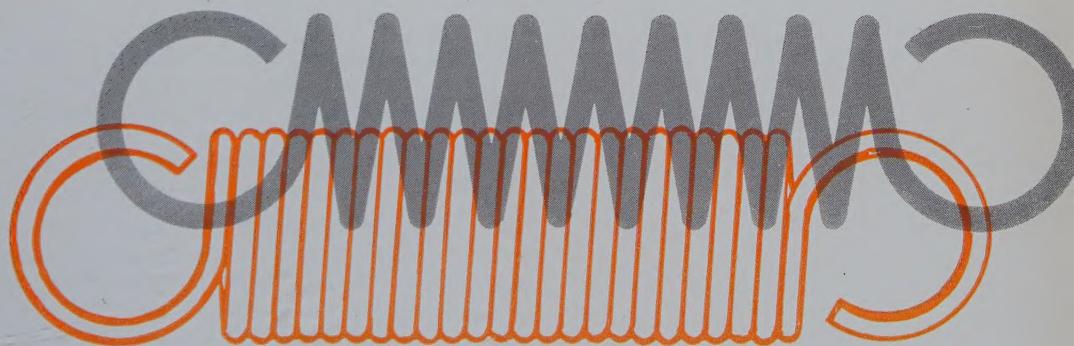
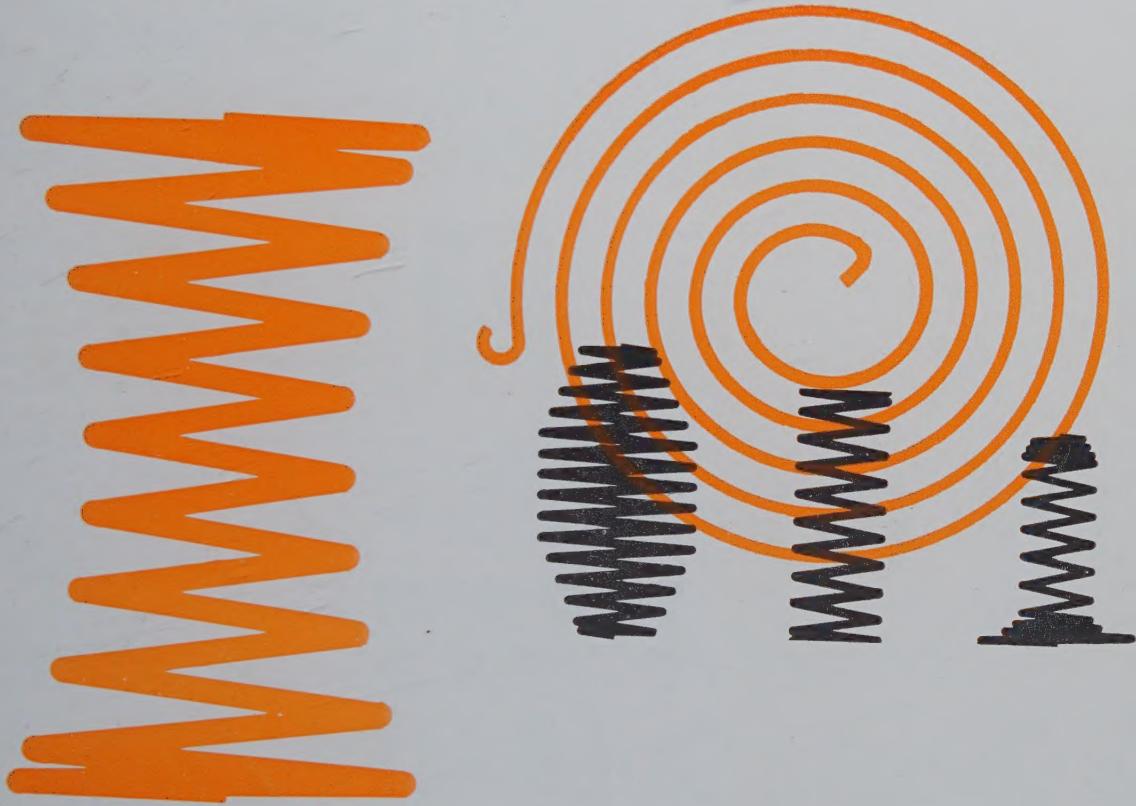
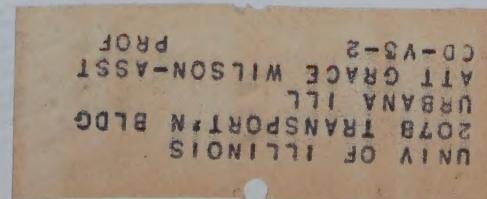


GRAPHIC SCIENCE



Spring Drafting Principles

JUNE 1960



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GRAPHIC SCIENCE

THIS ISSUE: 11,500 COPIES

JUNE 1960

VOLUME 2

NUMBER 6

The Magazine of engineering drawing management, covering drafting, reproduction and microfilming, technical illustration, drawing standards and drawing filing in all industries.

ARTICLES

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IRWIN WLADAVER
- Business Manager
DAVID Z. ORLOW
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A. F. SCHEAR

Supervisor, Technical Publications
Dept.
De Laval Steam Turbine Co.
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Drafting Time Data?

Sirs:

Your March 1960 issue, page 44, described the purpose and functions of the Design-Drafting Council of Delaware Valley. Please be informed that we would enjoy participating and exchanging information on the subject of Design-Drafting.

In addition the following is a specific problem in which we are particularly interested:

"What is the average time for drafting preparation of various size drawings ("A," "B," "C," etc.) of electronic or electro-mechanical equipment and components?"

Any information on this subject, whether it be a rule-of-thumb or statistical averages, would be appreciated.

J. R. PELAMATI

Director, Project Engineering Services
Librascope Division
General Precision, Inc.
808 Western Avenue
Glendale 1, Calif.

Letters

Photo-Drawings

Sirs:

You may be interested in some suggestions I have concerning on-the-spot photo-drawings. The article by J. H. Smith of Polaroid Corporation precipitated this letter.

Background—For many years as a designer and teacher I have felt the need for an 8½-by 11-inch Polaroid camera. My reasons: (1) If you use small photographs as Mr. Smith indicated, you will eventually strain your eyes. I have found 8½-by 11-inch to be comfortable to work with and easy to store (it fits in a loose leaf file.) (2) In teaching, overhead projectors are used to some extent. If they are to operate economically, the slides must be made inexpensively (time and money). Polaroid fulfills these requirements. But if one is to make notes on the slides (very common practice) the present 3½- by 4½-inch is too small. Again, 8½- by 11-inch is the preferred size. It would permit the addition of notes and would file easily.

I have suggested to Polaroid that a plate-back adapter be made by them for Graphic cameras.

H. D. MACNARY

Asst. Professor, M. E. Dept.
Montana State College
Bozeman, Mont.

Name Change

Sirs:

I sincerely appreciate the opportunity of receiving GRAPHIC SCIENCE and herewith extend congratulations on its prompt success.

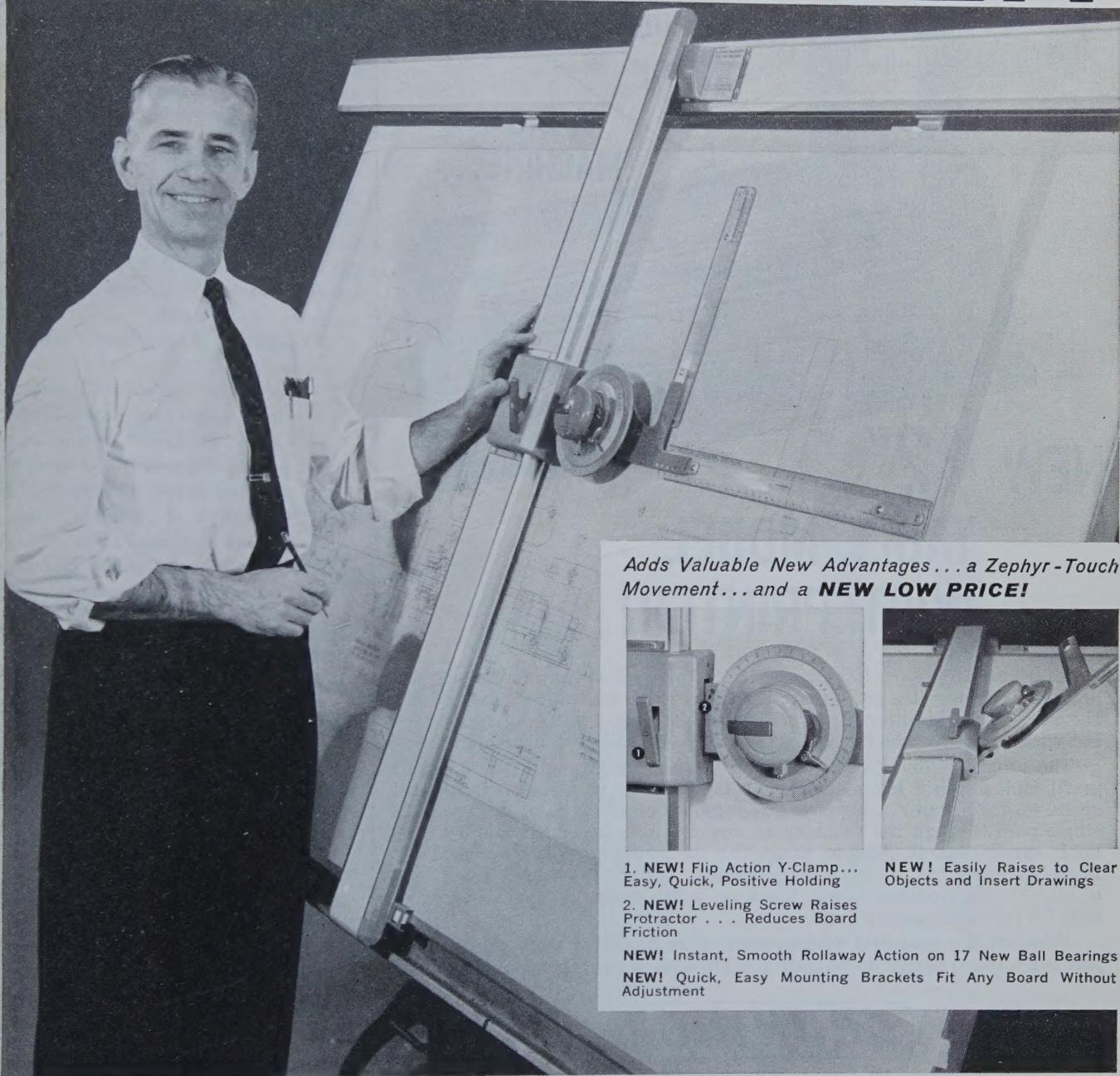
I've often heard it said, "What is needed is a magazine for draftsmen." Judging from the tenor of the articles and advertisements in the issues I've read, I'd like to reiterate, "What is needed is a magazine for draftsmen."

To wit, gentlemen, you've got a fine publication but the title should be

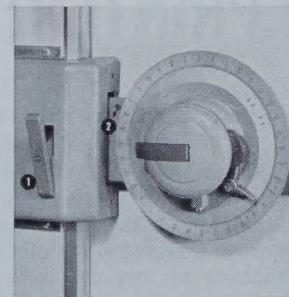
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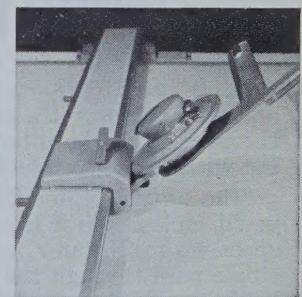
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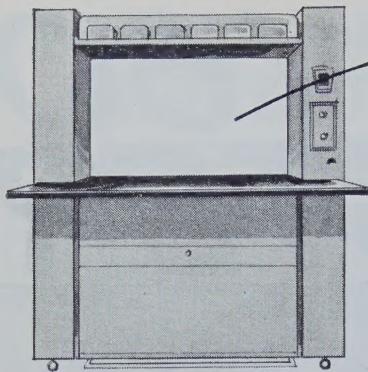
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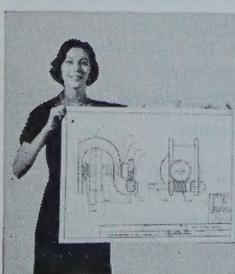
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Letters

changed to GRAPHIC SCIENCE—The Magazine for Drafting Supervisors, or putting it more subtly, . . . The Magazine of Drafting.

As a supervisor, I'd say the scope of your articles fulfills the purpose intended. As a draftsman, however, I couldn't care less about articles on reproduction processes, *et al.*

In all earnestness, I'd like to suggest that the emphasis be placed on articles, the subjects of which would be of greater interest and benefit to the journeyman draftsman. For example, you could shed some new light on these old chestnuts:

"Specifying Sheet Stock Thicknesses."

"Specifying Screw Clearance Hole Diameters and Their Center Distance Tolerances."

"Understanding and Portraying the 'End Result' Concept."

"Clarification of AWS Welding Symbol Vagueness."

"The Extent of Implied Dimensioning and Tolerancing."

"Practical Applications of MIL Std-10 Symbols."

"Elements of 'Simplified Drafting' that are Generally Accepted."

"The Pros and Cons of 'True Positional Tolerances.'"

ARTHUR E. JASKOWER

R. D. No. 2

Bound Brook, N. J.

Editor's Note: Since the receipt of the above letter, we have deleted the subhead of GRAPHIC SCIENCE. Note that on page three we have substituted a phrase which more effectively covers our actual readership, "The Magazine of Engineering Drawing Management."

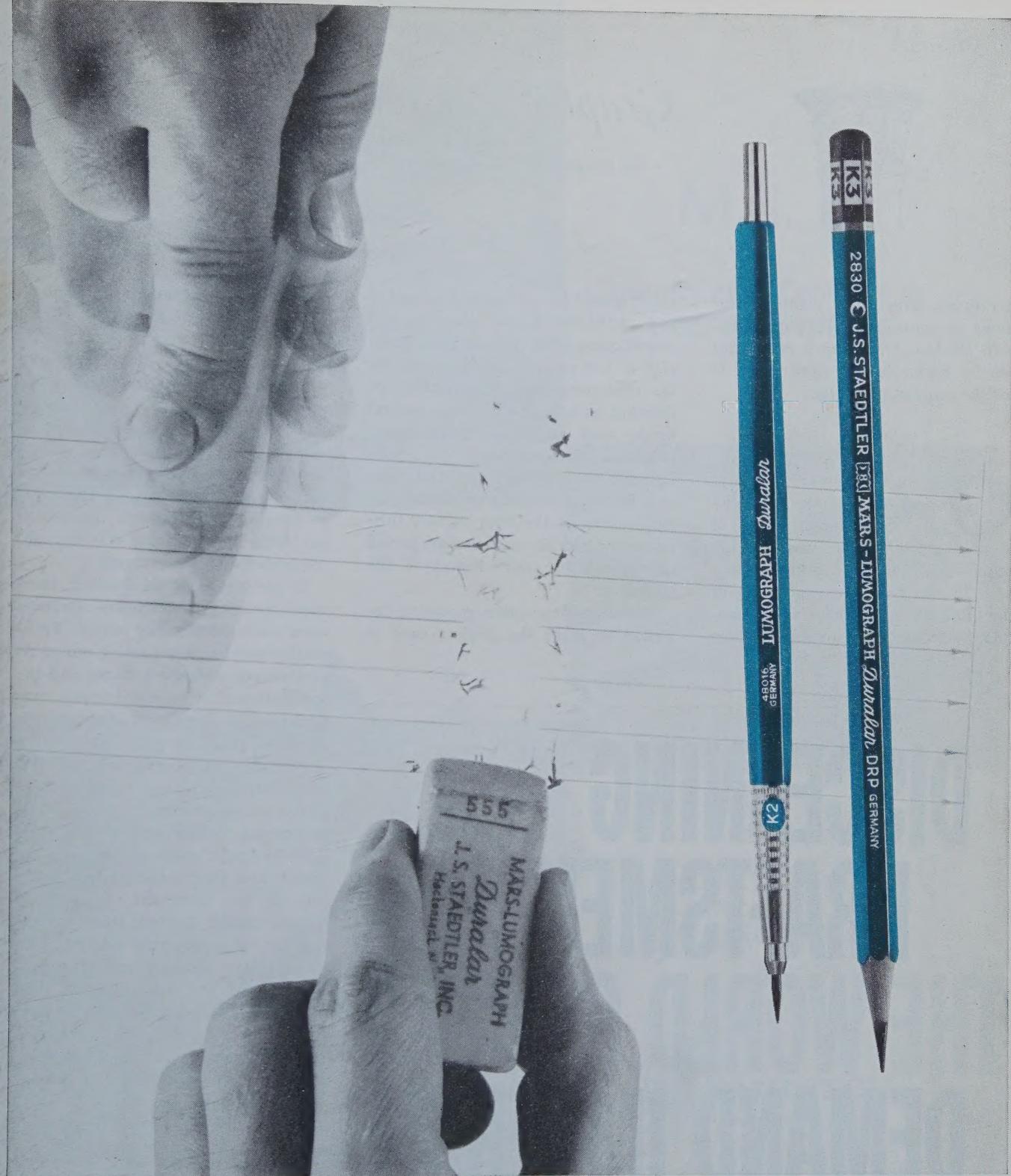
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Sirs:

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Graphic Perspective

by Eleanor W. Thompson

Editor's Note: We continue our series of guest-written "Perspectives" with Frederic G. Higbee's interesting article, begun in the April issue. It will be concluded in July.

by Frederic G. Higbee

ONE OF THE MOST significant and far-reaching influences in the development of graphic representation was the acceptance, early in the 20th century, both by teachers and draftsmen, of the *third angle* method of representation. With the moot question of how

views should be arranged, disposed of and settled for all time, theorists and practitioners alike turned their energies in the years which followed, to the refinement and improvement of drawing as a language. As a natural result, more and better literature on graphical representation was published both in the form of textbooks and in magazine articles during the first quarter of the 20th century than had appeared in any similar period throughout the entire history of the subject.

Books on descriptive geometry designed to make the subject easy to

understand, to illustrate the applications of descriptive geometry, and presenting the subject from the standpoint of the *third angle* appeared with almost clocklike regularity. But aside from the improvement in presentation, and in the study of applications, no great advances were evident in subject matter. The pioneer Monge had covered the field, and 135 years of scrutiny and research has added but little to his extraordinary and comprehensive achievement.

In the textbooks on drawing, however, great and noteworthy advances were made during this period. Technical education was passing out of its preliminary adolescent stages and the application of science to industry was becoming an actuality and not merely a dream.

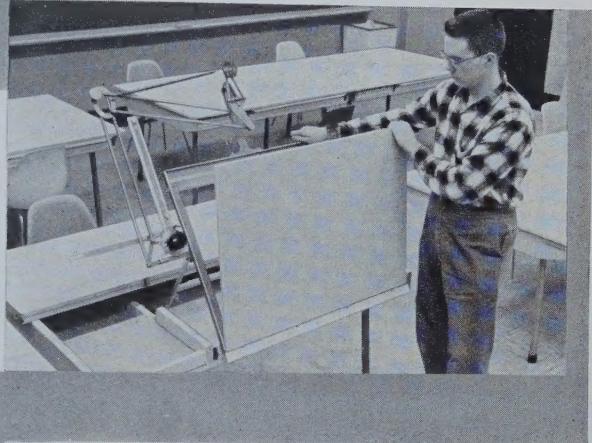
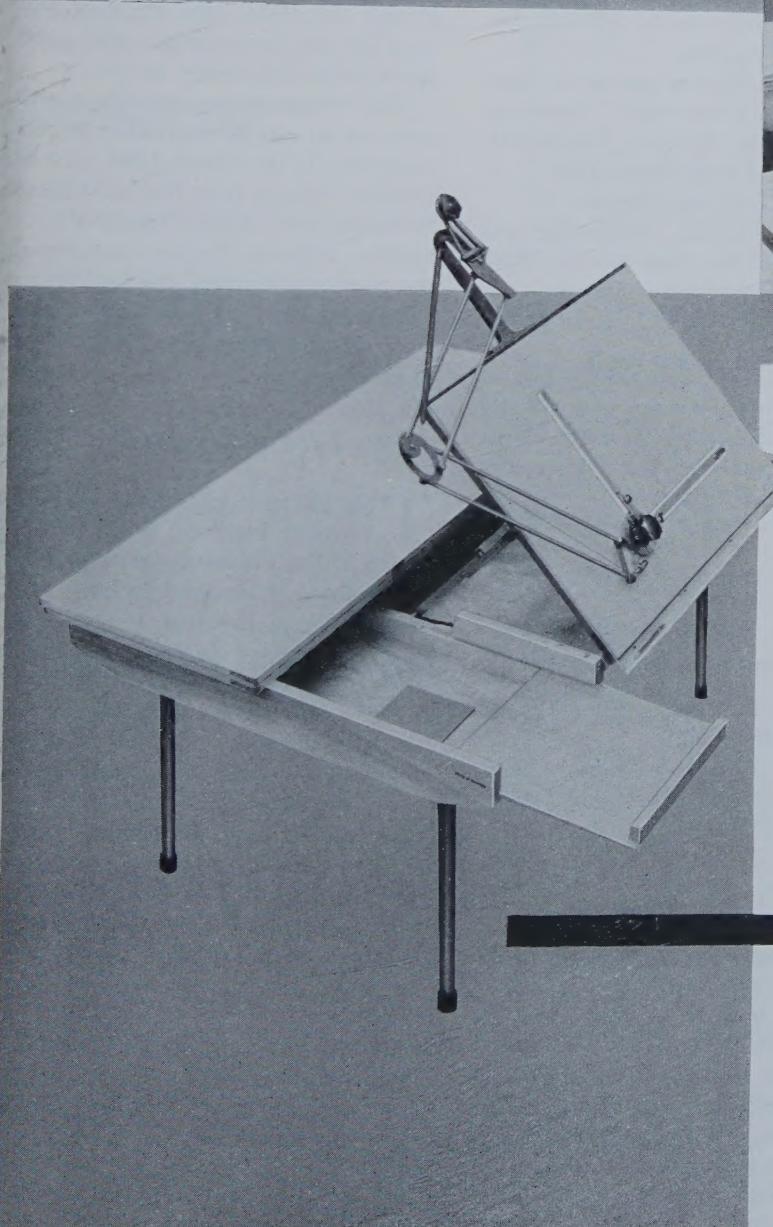
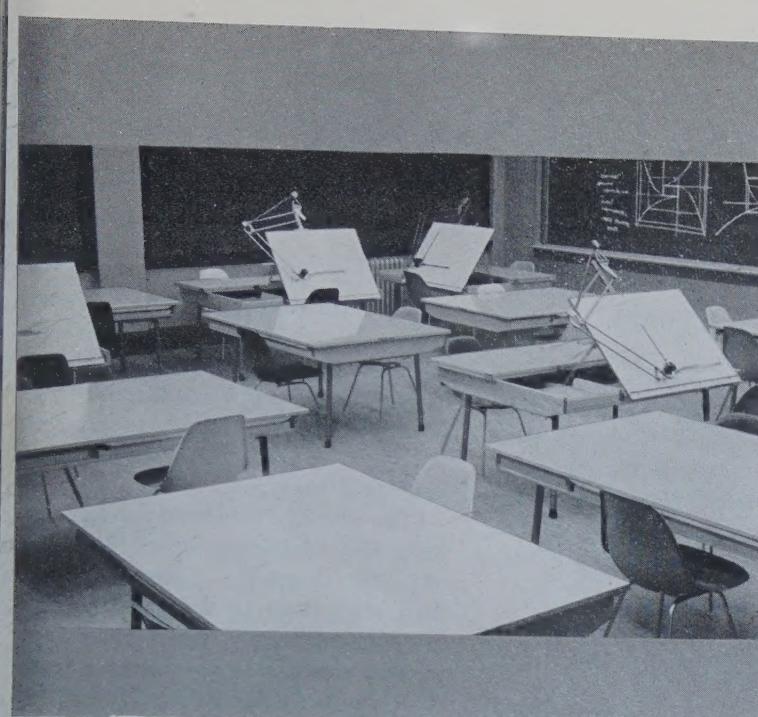
Not only as a result of this, but also because of the recognition industry was bestowing upon education in general, college-trained draftsmen were finding a place in the industrial world, and their influence was being felt in the literature of graphical representation. Indeed, many of the teachers of engineering subjects were drafted from industry and after having learned the limitations of their own college training, began a new era in technical teaching. For the first time, the whole subject of graphical representation: the theory of projection, the application of this theory to shape description, size description, and the application of shape and size description to the general field of graphic description, was joined to the old pedantic routine of geometrical drawing and the manipulation of drawing tools to make a comprehen-

(Continued on page 34)

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This article is based on a portion of "The Development of Graphical Representation," by Frederic G. Higbee, published in the *Journal of Engineering Drawing*, May 1958. The article was reprinted in the *Journal* by special permission of McGraw-Hill Book Company, from "Proceedings of the Engineering Drawing Division Summer School," conducted at Washington University, St. Louis, Mo., in 1946.



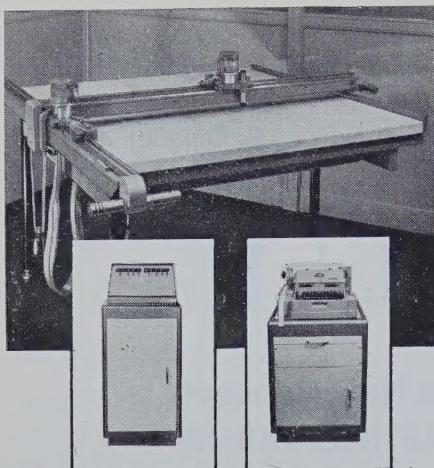
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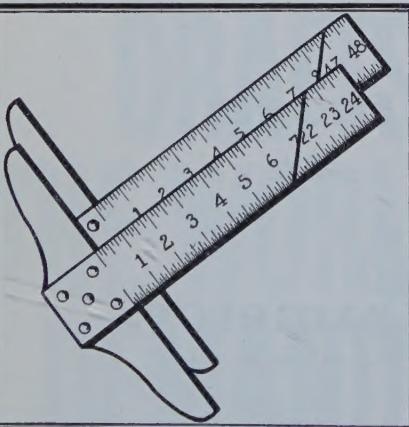
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Microfilming: DOD

MILITARY REQUIREMENTS for microfilming drawings and associated data were formally standardized on April 15, 1960, with the announcement by Herman C. Hangen, Director, Armed Forces Supply Support Center, of approval of the following nine documents:

Military Specifications

MIL-M-9868—Microfilming of Engineering Documents, 35MM, Requirements For.

MIL-P-9879—Photographing of Construction/Architectural Drawings, Maps and Related Documents, 105MM, Requirements For.

MIL-C-9877—Cards, Aperture.

MIL-C-9878—Cards, Tabulating and Aperture for Engineering Data Micro-Reproduction System.

Military Standards

MIL-STD-804—Formats and Coding of Tabulating and Aperture Cards for Engineering Data Micro-Reproduction System.

MS-21319—Gage, Aperture—Card, #201-1.

Interim Federal Specifications

(Approved 4 April 1960)

L-F-00315(BuWeps) — Film, Diazo-type, Microfilm.

L-F-00320(BuWeps) — Film, Photographic, Heat Developing (Microfilm, 35MM).

L-F-00334(BuWeps) — Film, Photographic, Microfilm (Black and White).

Mr. Hangen's announcement reported the significant accomplishment of a joint industry-military team, the EDMS-0009 Ad Hoc Committee, which has studied the problems of microfilming and use of engineering data within the Defense Department during the past year.

New possibilities for inter-service exchange of engineering data are

opened through use of microfilmed drawings and related data. When fully implemented, the Department of Defense Engineering Data Micro-Reproduction System aims to reduce repetition in data received to support operating programs.

The Armed Forces operate with active files containing more than 50,000,000 drawings. These drawings find many uses in the development, production, supply, and maintenance of weapons and supporting material. Uniform methods employed for microfilming this data, plus standard formats for data presentation, offer great space, time and money savings.

The foregoing announcement will come as no surprise to readers of this magazine. In the March 1960 issue of *Graphic Science* (pp. 15-18) William S. Hutchinson of the Armed Forces Supply Support Center, previewed the microreproduction standardization story in an article titled "Microfilming and Management of Engineering Documents."

Report from Wisconsin

THE EFFECTIVE DRAFTING Management Institute, held April 7 and 8 at the University of Wisconsin at Madison, is reported to have presented one of the best programs to date. Planned for chief draftsmen and other supervisory personnel of product-oriented drafting departments, the program included talks on drafting department organization, on the selection, training and motivation of draftsmen, on auditing of drafting work, and on dimensioning for numerical control. According to Robert A. Ratner, Director of these Engineering Institutes, over half of the men attending had been at one or more previous drafting institutes.

A detailed program of the Effective Drafting Management sessions appeared in these columns in the April issue of *Graphic Science*. Feature articles based on the papers presented, will appear in this magazine beginning with the July issue.

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First of Three Parts

Spring Drafting Principles

How to cut drafting time while producing drawings that will enable the supplier to make the best springs at the least cost

by Albert L. Godshall and Gerald L. Kilmer

SPRING DRAFTING is precision drafting, requiring the highest quality of draftmanship. Unless a draftsman specializes in springs, he probably finds them difficult to draw, not only because of the different radii, tangents, and straight sections involved, but also because of the general ambiguity of terminology and graphical interpretation surrounding spring drafting.

Over the long history of mechanical design, dozens of different spring types—and millions of spring variations—have evolved. Springs are generally classified into five types which represent the bulk of modern usage: compression, extension, torsion, spiral, and constant force springs; (see Figures 1-5). These classifications are based on the manner in which a spring stores and delivers energy.

Other interesting and commonly used types of springs are covered under a "miscellaneous" heading. In this category are: (1) flat springs (cantilevers, beam and leaf), (2) bent forms, (3) snap rings, and (4) spring washers (Figure 6). These springs store and deliver energy through bending.

Many springs commonly designated as "special" types may be considered as variations of the five basic categories. For example, conical springs, volute springs, hourglass springs, and valve springs are all varieties of compression springs.

HOW TO SPECIFY SPRINGS VERBALLY

ONE OF THE MOST important general points to be made about spring drawing is that not all springs

need to be drawn. Many springs can be specified verbally. If the draftsman knows what springs can be verbally specified and how to specify them, he will be able to avoid much tedious detail.

Most common helical compression springs can be completely described verbally. With the common helical extention spring, it is sometimes necessary to make a sketch of the ends. While much of the torsion spring can be verbally specified, a sketch is always needed to show the angles of arms, initial and final, and other considerations such as points of application of force and additional bends if any.

Approximately 90 percent of all wire springs bought today are either conventional, helical compression or extension springs. (About three-

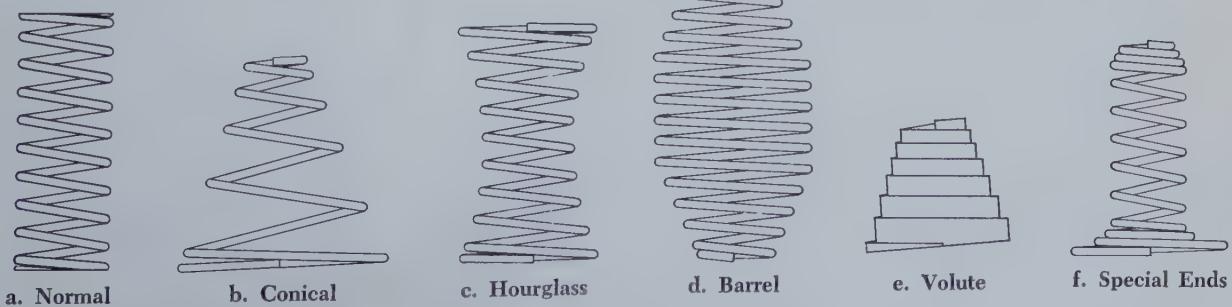


FIGURE 1. Compression Springs

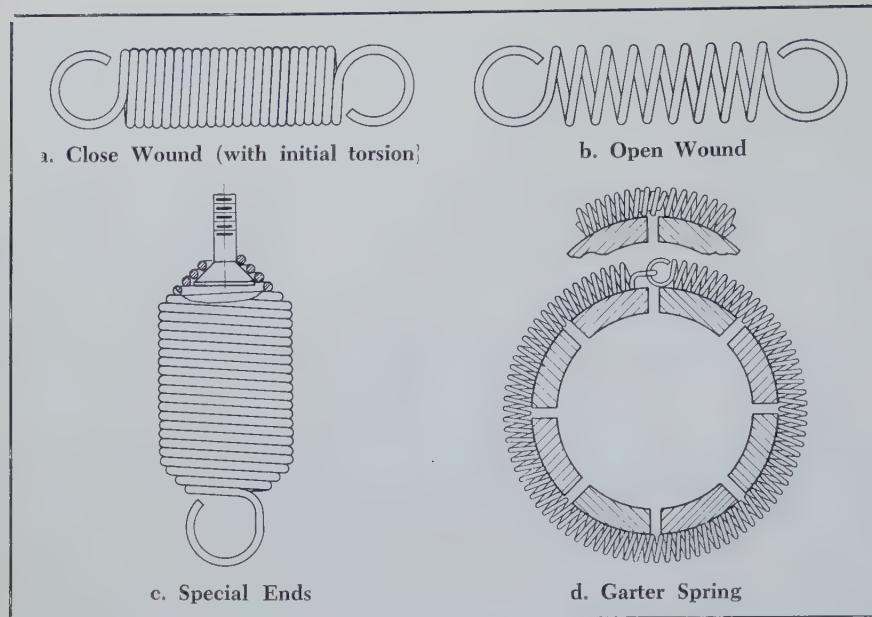


FIGURE 2. Extension Springs.

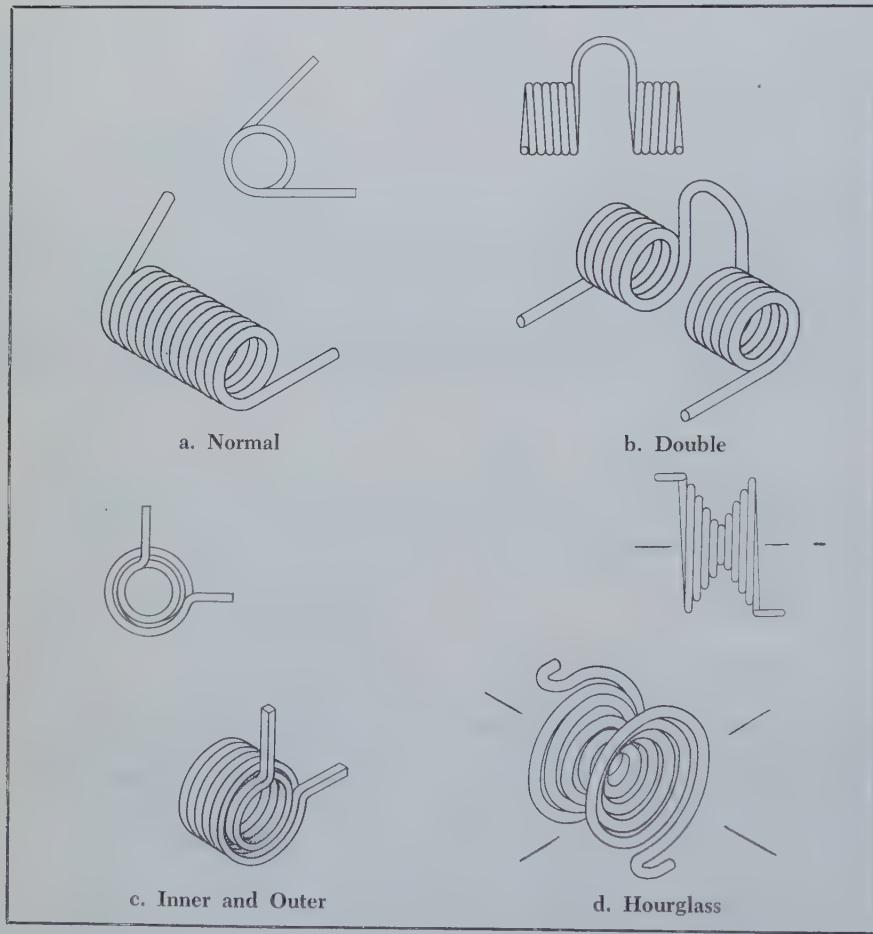


FIGURE 3. Torsion Springs.

fourths are compression springs.) As we have said, most of these springs can be verbally specified; yet, surprisingly enough, only a small percentage are.

Because of the great number of springs which are drawn when there is no need for drawing them, it be-

hooves a draftsman to know how to specify verbally. In this way he can eliminate much drafting effort by telling the spring designer by means of a verbal "drawing" what information is needed for a verbal specification.

The form illustrated here (Figure 7) is suggested as a practical, standard

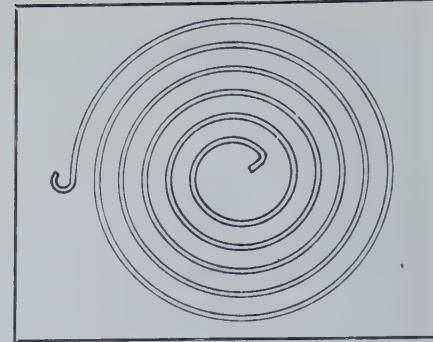


FIGURE 4. Spiral Spring.

form for verbally specifying the normal helical compression spring. Forms for verbal specification of extension springs, and torsion springs will be shown further on. There is one standard form for each spring. With these forms, spring specifications can be listed in a clear, concise orderly manner.

Note that each form calls for four broad areas of information: load requirements, service requirements, physical requirements, and calculated values. It is not necessary to supply all four areas of information together since the load and service requirements are used only to obtain the calculated values. Given the load, service, and physical requirements, a spring manufacturer should be able to design the spring—in other words, obtain the calculated values. Thus a spring can be verbally specified two ways. One: give the load, service, and physical requirements and allow the spring manufacturer to obtain the calculated values. Two: give the spring supplier the calculated values and the physical requirements.

Actually, it is more sensible to allow the spring manufacturer to do the calculations, since for the non-expert such calculations generally prove to be an extremely tedious and time-consuming operation. Also, if this is done it is not necessary for the draftsman or the designer to know the actual design procedure used to obtain the calculated values.

Another suggestion, related to using verbal descriptions, is to use standard drawings. A company that buys springs in volume should have a series of standard drawings.

HOW TO DRAW AND DIMENSION SPRINGS

SPRINGS which are "special" sometimes have to be drawn. These conical, hourglass, barrel, voulte, oval,

and special ends; under the extension form: garter, and special extension spring ends; and others: torsion, spiral, and constant force springs such as the Neg'ator, Flex'ator, and Spir'ator springs. Most of these springs need not always be drawn. That is, all the necessary dimensions are sometimes more easily made part of the verbal description.

In general the draftsman should consult with the designer in an effort to clarify and simplify design. It is basically the function of the engineer or designer to change end details, apply tolerances, specify finishes, etc.

COMPRESSION SPRINGS

HELICAL COILED compression springs store energy by being compressed along the axis of winding. When permitted to release this energy, they expand in length and exert a pushing force.

Common or normal compression spring (Figure 1-a). The normal compression spring can be completely described verbally. Therefore, the form for verbally specifying compression springs (Figure 7) should be used. The form is largely self-explanatory. (Typical figures are shown on the form). Any two of the load requirements listed will establish load characteristics. Specify the two most important. Do not specify more than two, as this places impractical limitations on the manufacturer. Service requirements and physical specifications are self-explanatory and should be derived from the application. If calculated values are given and the designer's calculations are available, these should be included to permit the spring manufacturer to check them.

Conical springs (Figure 1-b). There are three dimensions peculiar to conical springs which are not provided for on the specification form for compression springs. These are: length of the conical section, smallest and largest OD, and number of coils. This information does not in itself require the drawing of the conical spring. It can be given verbally in the remarks section of the specification form. For example, it could be specified that the conical section is 3-in. long, and that the spring OD increases from $\frac{1}{2}$ -in. to 1-in. in four coils. However, since these are calculated values, they do not have to be given unless the

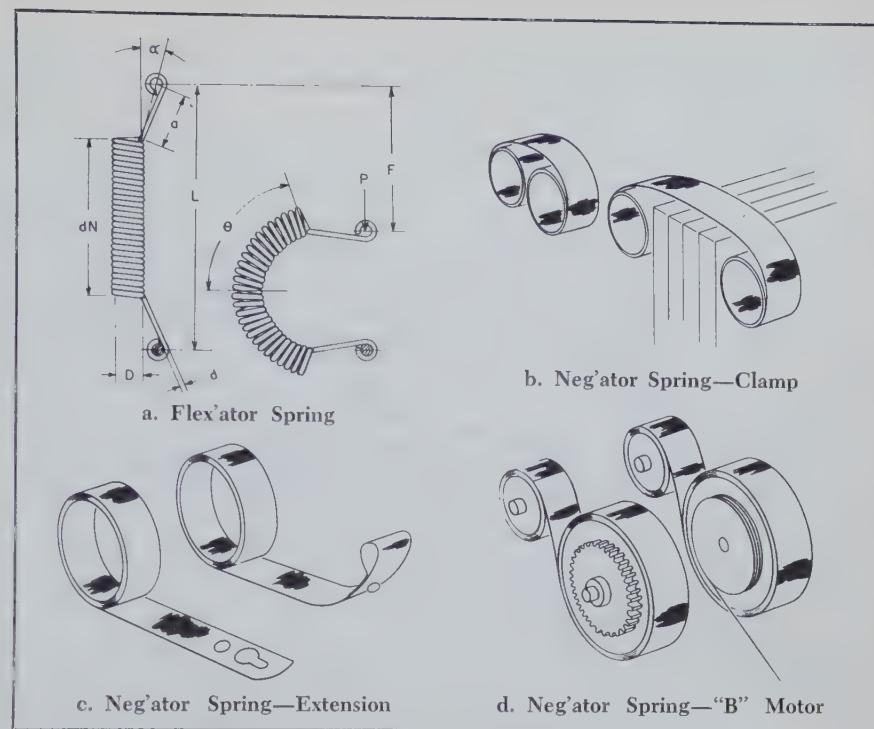


FIGURE 5. Constant Force and Torque Springs.

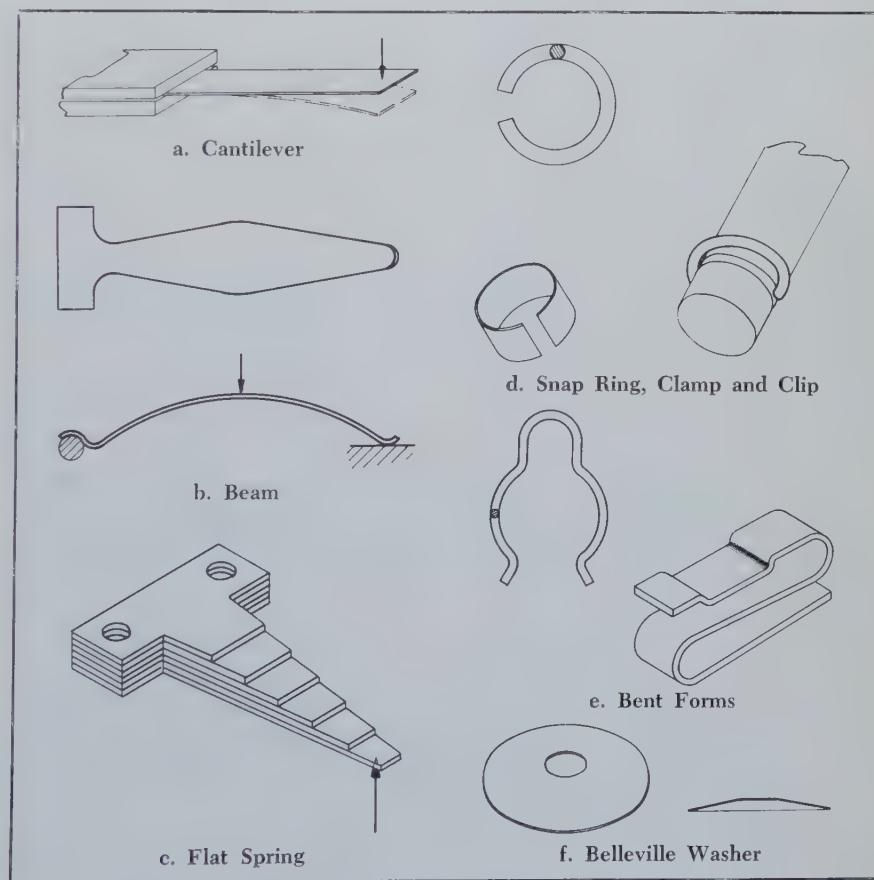


FIGURE 6. Miscellaneous Springs.

other calculated values are given, i.e., unless the designer does the calculations.

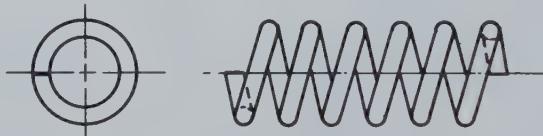
A conical spring should be drawn only when it is necessary to give the pitch between each coil. (The pitch

of a conical spring usually changes from coil to coil.) It is generally easier to dimension pitch change on the drawing. However, it's a very unusual conical spring application that requires such precision. The vast

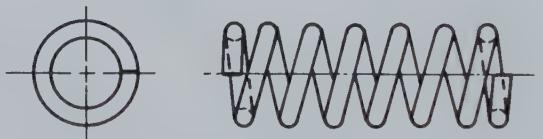
LOAD REQUIREMENTS—SPECIFY ONLY TWO					
1. FREE LENGTH	IN. \pm	IN.	IN.	LB. AT	IN. LENGTH
2. INITIAL LOAD	200	LB. \pm	30.	2.305	IN. LENGTH
3. FINAL LOAD	200	LB. \pm	30.	2.125	IN. LENGTH
4. GRADIENT	LB./IN. \pm	IN. BETWEEN	IN. AND	IN. OR	
		IN. BETWEEN	LB. INITIAL LOAD AND	LB. ADDITIONAL LOAD	
SERVICE REQUIREMENTS					
SPRING MUST OPERATE A MINIMUM OF <u>INFINITE</u> CYCLES BETWEEN <u>2.305</u> AND <u>2.125</u>					
REQUIRED DEFLECTION BEYOND L_2 <u>2.125</u> (FOR ASSEMBLY, ETC.)					
MAXIMUM TEMPERATURE <u>150</u> °F.					
SPECIAL					
LOAD REQUIREMENTS MUST BE MAINTAINED AFTER ABOVE SERVICE REQUIREMENTS HAVE BEEN FULFILLED					
PHYSICAL REQUIREMENTS					
MAX. O.D.	<u>1.438</u>	IN. FOR	DIA. HOLE	MIN. I.D.	<u>.938</u> IN. FOR DIA. SHAFT
MATERIAL	<u>0.6 chrome silicon</u>			FINISH	<u>rust inhibiting oil</u>
TYPE OF ENDS	<u>S & G</u>			DIRECTION OF WIND	<u>Left</u>
SQUARED & GROUND ENDS TO BE NOT MORE THAN <u>2.5</u> ° FROM RT. ANGLE TO AXIS					
CALCULATED VALUES					
WIRE DIA.	<u>.218</u>	$\pm 3\%$	OUTSIDE DIAMETER	<u>1.400</u>	IN.
FREE LENGTH	<u>2.905</u>	IN.	ACTIVE COILS	<u>6</u>	
SOLID HEIGHT	<u>1.800</u>	IN.	GRADIENT	<u>333</u>	LB./IN.
*FOR DIAMETERS UNDER .034" NOMINAL WIRE DIAMETER MAY BE VARIED .001" SO LONG AS ALL OTHER REQUIREMENTS ARE MET.					
REMARKS					

FIGURE 7. Spring Specification Form—Compression Springs.

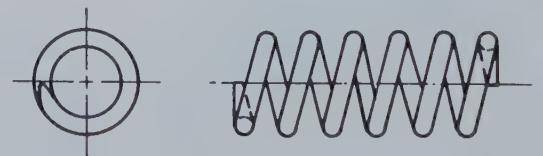
Plain Ends



Ends Squared, not Ground



Plain Ends Ground



Ends Squared and Ground



FIGURE 8. Types of Ends—Compression Springs.

majority of applications are satisfied by the accuracy in pitch that results from the usual manufacturing process.

Hourglass Spring (Figure 1-c). Practical requirements for the "hourglass" shape are nearly non-existent. Where a user wishes to specify one it is highly advisable to confer with a spring supplier as to how they should be specified, or whether an alternative conventional design might accomplish the same objective at a saving.

Barrel Spring (Figure 1-d). Somewhat the reverse shape of the hourglass spring, the barrel spring requires additional dimensions. However, for manufacturing reasons, it is usually best to draw a barrel spring and to give the change in coil OD for several lengths of the spring. Other dimensions can be given on the specification form. The barrel spring can be made with a continuous curve; i.e. with the OD changing from coil to coil, or it can be made with the coil OD constant in the middle section of the spring. This type is cheaper to manufacture, and is the more commonly specified.

Volute spring (Figure 1-e). A volute spring should always be drawn and each coil fully dimensioned. The specification form can be used for the basic dimensions.

Standard Ends. It is not necessary to draw all compression spring ends. The four most common types of compression spring ends, which can all be specified verbally, are (Figure 10):

1. Plain ends;
2. Ends squared not ground;
3. Plain ends ground;
4. Ends squared and ground.

"Ends squared not ground" or "squared ends" are terms used when the pitch of the last coil at each end of a compression spring is reduced in order to "square off" the ends as much as possible. When these ends are ground to further improve the degree of squareness, they are then referred to as being squared and ground. "Plain ends ground" and "squared ends ground" are, of course, more expensive because of the grinding operation.

Special Ends (Figure 1-f). All compression spring ends, other than the four standard ones must be drawn and fully dimensioned.

Editor's Note: Messrs Godshall and Kilmer of Hunter Spring Co., Lansdale, Pa., will continue their article on spring drafting in the July issue.

Drawing Numbering Systems

Meaningful numbers with flexibility, and adherence to military requirements characterize a good engineering document identification system for complex products

by Robert D. Furay

THE MULTITUDE of engineering documents required to define a large and complex product must each be identified. This requires considerable forethought in order to prevent duplication and confusion. In the following discussion, we will attempt to establish some of the basic requirements of a functional system of drawing identification.

Certain military standards¹ and specifications² presently in force, establish minimum requirements which must be fulfilled by those manufacturing under military contracts. Although these present certain limitations, they are not so strict that individual manufacturers cannot vary their own numbering systems, almost endlessly, to best meet their specific needs and methods of operation.

Admittedly, all manufacturers do not produce for the military, and are not bound by the military requirements. Since a system for identifying engineering documents should not be changed any oftener than absolutely necessary, however, it seems advisable even for non-military manufacturers to design their identification system around the military requirements. This will preclude changing

should military contracts subsequently be forthcoming. This discussion therefore, will in no way violate the framework of military requirements.

The use of numerical digits is obviously the most desirable, since it is the only system which permits an endless chain of unduplicated identities. The combination of alphabetical characters and numerical digits may be a source of potential problems, such as (1) similarity (i.e., 8 and B, 4 and A, 5 and S, etc.,) and (2) inability of electric accounting machines to handle both types of characters. Nevertheless, it is sometimes advisable to include alphabetical characters along with the numerical digits, in order to permit repetitive use of the digit combinations, thereby maintaining a reasonable maximum length of the identifying number.

With this in mind, it may seem sufficient to start with 10, 100, or 1,000 and assign the next available number to each succeeding document, using A10, A100, or A1000 if the numbers get too large. But, before plunging into such a meaningless system of identification, let us consider various aspects, and establish certain ground rules as a foundation upon which a functional system of identification can be established. These aspects may be more, or less, than those requiring consideration by all manufacturers; the intent, however, is to highlight the major ones, and thus to

establish a starting point from which each manufacturer may progress, depending upon his own needs.

MANUFACTURER IDENTIFICATION

THE QUESTION arises as to the need for including some sort of an identification in the document number to indicate the manufacturer originating the document. In most cases, the document itself will include the manufacturer's name or trademark, but many times the document identification number is used in correspondence and discussions without the inclusion of the document itself. Such identification is strictly the result of the desires of the individual manufacturer, but it should not be forgotten that such identification is, in a sense, free advertising.

DIVISION IDENTIFICATION

DIVISIONAL IDENTIFICATION is not, of course a problem for companies consisting of one division. It should be given some thought, however, for diversified production frequently results in separate divisions within a company. If properly considered beforehand, divisional separations need not result in chaos in the drawing numbering system.

The need for divisional identification in the document number falls into the same category as the Manu-

¹MIL-STD-31, *Numbering and Coding of Engineering Drawings, Associated Lists and Documents*; mandatory for use 1 April, 1959.

²MIL-D-70327, *Drawings, Engineering and Associated Lists*; mandatory on all new military contracts, replacing MIL-D-5028.

facturer Identification, in that there may be no need or desire on the manufacturer's part to identify his various divisions. The fact that a multi-division company chooses to include the manufacturers identification in the document number does not necessarily mean the separate divisions must be identified.

Conversely, the fact that no manufacturer identification is included does not necessarily mean the divisional identity should not be included. Each aspect should be considered separately to determine the advantages along with the disadvantages of each identity. Consideration should be given to the geographical location of the various divisions as well as the identity of documents which would be common to all divisions.

INDIVIDUAL PRODUCT IDENTIFICATION

MOST MANUFACTURERS are fortunate enough to have more than one product on the market, in which case it is sometimes advisable to identify the individual product for which a given document was originated. The use of a given document for subsequent models or parts must not change the identification number, for this will lead only to confusion. The individual product identification has certain merits for manufacturers who have a relatively few large products, but may be completely useless, if not disadvantageous, for those manufacturers who have a multitude of small products in the accessory category, many of which use common parts.

The engineering definition of a large complex product requires not

only a large number of documents, but a number of different types of documents. Such documents include engineering drawings, various types of specifications, standards, etc. The need for separate identity of these different types of documents is undoubtedly more acute than that for the manufacturer or divisional identification. It is certainly desirable, if not necessary, to identify the various types of documents, if for no other reason than filing. For instance, specifications are not normally filed with engineering drawings.

BASIC IDENTIFYING NUMBER

IN ADDITION to the considerations given to the identity of the manufacturer, division, product, etc., some thought should be given to the advisability of further identifying the drawing with respect to its ultimate use. For example, the basic identifying number may be used to indicate the system, location, responsible design group, etc., or any combination thereof. The number may further differentiate between major assemblies, subassemblies, and detail parts within a given system. To some, this may be cutting the line of identification too thin, but there are advantages to be gained from such a detail identification.

All physical parts must, of course, be identified to control their flow through the planning, fabrication, assembly and installation stages, as well as for spares procurement. These parts, are defined by a specific engineering drawing, and the question immediately arises as to whether the

part number and the drawing number should be the same.

This will depend in part upon the types of engineering drawings which a particular manufacturer uses. Some drawings are prepared as mono-details (one part to a drawing), others as multi-detail drawings (two or more parts defined on a single drawing).

For example, if all parts are defined on individual drawings (that is, a separate drawing for each part) then the drawing number and part number may be the same. The only problem here, and it is a minor one, is when referring to a specific number, it is impossible to determine whether it is the part, or the drawing to which reference is made. When multi-detail drawings are used, it becomes obvious that two or more different parts cannot have a part number identical to a single number of the drawing on which they are defined.

With the use of both types of drawings (mono- and multi-detail), it becomes necessary for consistency's sake to establish the fact that the drawing number must always be separate and distinct from the part number. However, to meet the military requirements, there must be a relationship between the part and drawing number to this degree: that the part number must always include the basic drawing number.

TYPES OF NUMBERS

NUMBERING SYSTEMS can be subdivided into three basic categories.

(1) *Non-significant*. This type of number is made up of numbers or letters, or a combination of both, none of which have any significance. This defines the 1000, 1001, 1002 system mentioned earlier. It is by far the simplest, but affords the least advantages.

(2) *Semi-significant*. This is made up of numbers or letters, or a combination of both, some of which have a certain significance as defined by the manufacturer.

(3) *Significant*. This is made up of numbers or letters, or a combination of both, all of which have a significance.

Prior aspects for consideration all lead to the possible inclusion of certain identities in the document identification number. Since, as previously mentioned, a document number

SCHEMATIC BREAKDOWN OF DOCUMENT NUMBER

15 CHARACTERS MAXIMUM (including letters, numbers and dashes)

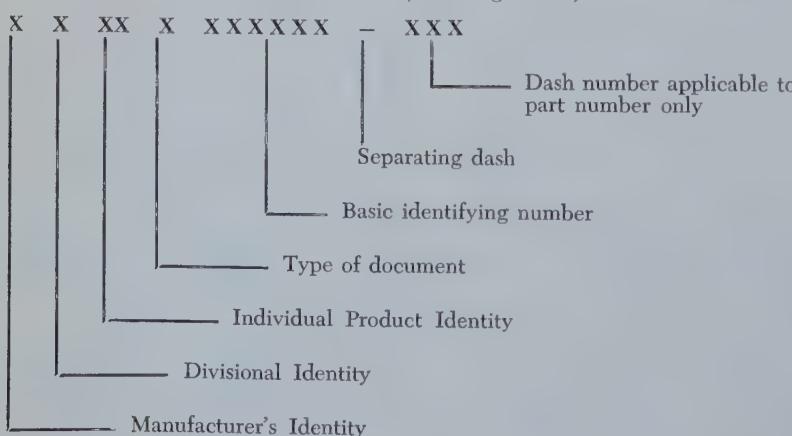


TABLE 1.

UNIT X	MAJOR INSTALLATION X	SYSTEM X	DRAWING TYPE X
0) Tail Surfaces	1 Basic 2 Horizontal 3 Vertical	0 General 1 Electrical	001-100 Major Assy's & Install.
1) Wing C/S	1 Basic 2 Structural Panels 3 Structural Ribs	2 Hydraulic 3 Pneumatic	
2) Wing O/P	1 Basic 2 Structural Panels 3 Structural Ribs	4 Instruments	
3) Fuselage Front Section	1 Basic 2 Cockpit 3 Windshield & Cowl 4 Structural Panels 5 Structural Frames	5 Landing Gear 6 Controls	101-500 Sub Assy's & Install.
4) Fuselage Mid Section	1 Basic 2 Structural Panels 3 Structural Frames	7 Armament	
5) Fuselage Aft Section	1 Basic 2 Structural Panels 3 Structural Frames	8 Fuel System 9 Engine Install.	501-99 Details

should not change once it is established, there are certain items which, because of their changing nature, should not be included. Certain of these are as follows:

1. Document revision identity
2. Document size identity
3. Code identification number (assigned to military contractors only)
4. Type or method of fabrication

EXAMPLES

UP TO THIS POINT, we have touched lightly upon certain aspects requiring consideration before establishing a system of identification, but as yet we have no tangible examples. For the purpose of presenting such an example, let us establish a hypothetical manufacturer recently separated into several divisions, actively engaged in the production of aircraft and missiles, along with their related components. More specifically, we will discuss the considerations of the division engaged in aircraft production.

It is recommended that there be a relationship in numbering systems for all of the individual divisions to avoid a duplication of numbers. Therefore, certain decisions must be made, or at least approved, on a level applicable to all divisions to insure this consistency. Although realizing that the identification system must be limited by the military requirements to

15 characters, it was decided to include as much common information as possible in the identification number, including the manufacturer, divisional, and product identity.

From this point on, the number will be the result of the individual divisional requirements. The aircraft division decided to establish further identification with regard to types of documents and detail system identification. Short of a completely significant number, this specific division was attempting to get all they could from their document numbering system.

Schematically, this document num-

ber could result in the breakdown, shown on page 20.

Manufacturer's Identity. A single letter "Y": for the "Young" Company is to be used on all documents regardless of the division from which they originated.

Divisional Identity. A separate number assigned for each division would be unchanged except for addition of divisions. All documents originating from the various divisions must include the identity of that division.

2. Aircraft
3. Missile
4. Research
5. Electronics

Product Identity. Defined by a combination of digits assigned, in sequence, for each new product. These product numbers will be assigned by each division separately and need no coordination between divisions.

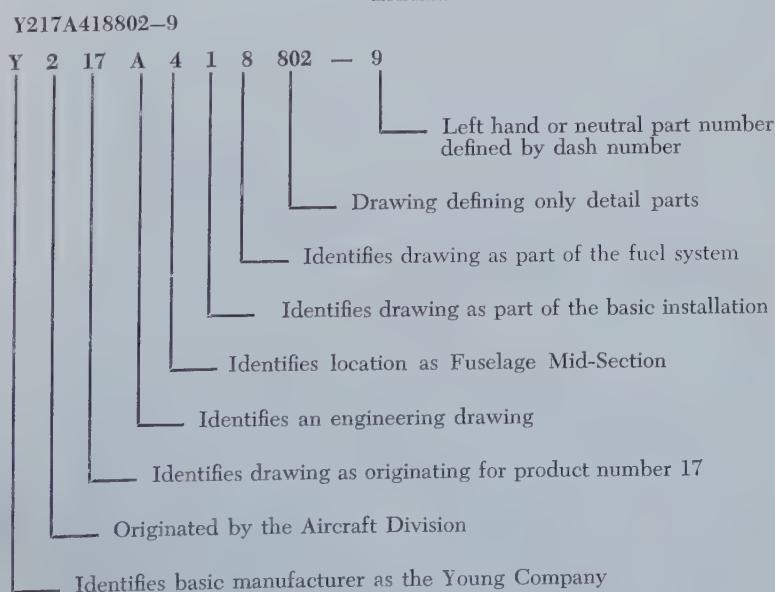
- 01 - Product 1
- 02 - Product 2
- 03 - Product 3

Type of Document. Defined by a single letter for each type. These identities should be common for all divisions to avoid confusion.

- Engineering drawing
- Company standard
- Specification-Procurement
- Specification-Acceptance
- Specification-System operational
- Specification-Material
- Specification-Process
- Etc.

Basic Identifying Number. This portion of the document number would be set up in accordance with

EXAMPLE 1.



EXAMPLE II.

Y217A220001-1

Y 2 17 A 2 2 0 001 - 1

Left hand or neutral part number defined by dash number

Drawing defining a major assembly or installation

Identifies drawing as part of the general installation rather than any particular system

Identifies drawing as covering structural panel

Identifies location as Wing Outer Panel

Identifies an engineering drawing

Identifies drawing as originating for product number 17

Originated by the Aircraft Division

Identifies basic manufacturer as the Young Company

Table 1, which will provide a detail definition of the part to some degree:

Part Number. This is a digit, or combination of digits, following the basic drawing number and separated by a dash. Left hand and neutral parts may be defined by a dash number, the last digit of which is an odd number. Right hand parts may be defined by a dash number, the last digit of which is an even number. These numbers are usually assigned in sequence except when the use of odd versus even numbers dictate otherwise.

Based upon the previous discussions, the resultant numbers appear similar to the samples shown here.

Once established, such a system provides flexibility in that it is adapt-

able to various types of documents and products, but at the same time it affords a direct relationship between the drawings of various products. For instance, Example III below is similar to Example I, except that it was originated for a subsequent product.

It must be emphasized that the foregoing Examples are only a few of many variations. For instance, the above numbers allow 999 detail (dash number) parts to be defined on a single drawing. If this is too many for some manufacturers then only two digits need be provided, allowing for 99 parts. In using the fixed fifteen characters, two characters may be used, for the manufacturer's identity (i.e., YC in place of a single Y). In

EXAMPLE III.

Y218A418603-7

Y 2 18 A 4 1 8 603 - 7

Left hand or neutral part number defined by dash number

Drawing defining only detail parts

Identifies drawings as part of the fuel system

Identifies drawing as part of basic installation

Identifies location as Fuselage Mid Section

Identifies an engineering drawing

Identifies drawing as originating for product number 18

Originated by the Aircraft Division

Identifies basic manufacturer as the Young Company

some cases the six-character basic number need be only five, thus permitting an additional character for other identities, or shortening the number below fifteen characters.

CONTROL

THE CONTROL of such a numbering system, although not difficult, is of major importance, for without sufficient control any well-planned numbering system can easily go astray. Regardless of the system devised, it is mandatory that it be controlled by a central source within a company, or division, as the case may be. This is necessary even with the simplest system for no other reason than to avoid duplication. But, with a system such as we have discussed, the control becomes important for reasons other than mere duplication.

To assign a number properly, the personnel within the "central source" must know certain facts which are available from the designer preparing the engineering drawing. These include the title of the drawing and the product for which it is being originated. A comprehensive review of the title will determine the basic identifying number. The product number and the basic identifying number can then be coupled with the fixed portions of the prefix, such as Manufacturer, Division, and type of document identities, to establish the complete identification. This number, when assigned, should be inserted in a card file for record purposes, and to prevent its inadvertent re-assignment. Part numbers (dash numbers) may be subsequently assigned by the designer as he needs them for any given drawing.

In summary, what ever number breakdown is used, it must be the one best suited to the manufacturer using it. It should result from careful planning and forethought and it should be consistently controlled from a central source within the company.

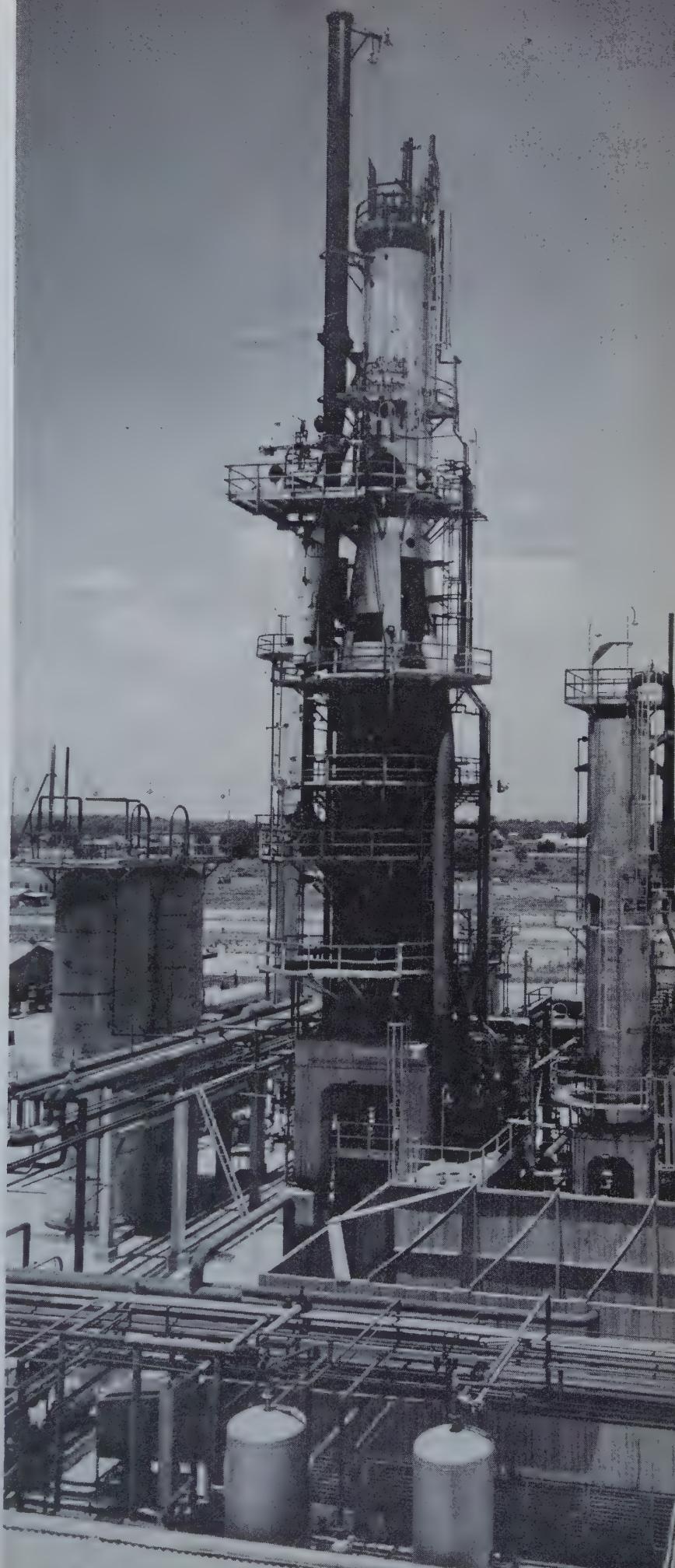
The Author

ROBERT D. FURAY is a Lead Engineer in the Drawing Quality Unit of the Engineering Department of Vought Aeronautics, a division of Chance Vought Aircraft, Inc., Dallas, Texas.

*The
Training of
Engineers
and
Draftsmen
in
Process
Work*

by M. F. Perkins

A forty-five-year-old firm, engaged in research and development primarily concentrated in the petroleum refining field, Universal Oil Products Company of Des Plaines, Illinois, is also a service organization, an engineering organization, and a manufacturing company, making catalysts, inhibitors and chemical additives. Its "products," in addition to the manufactured specialties, are its "know-how," sold to those who make gasoline, lubricants and fuel oil. Universal Oil Products and its wholly-owned subsidiaries have about 1800 permanent employees, exclusive of field construction forces.



Draftsmen and Engineers in Process Work

Qualified men develop rapidly when given opportunity to learn, proper recognition of accomplishment, and the incentive of advancement.

IN THIS DISCUSSION we are referring to the training of engineers and draftsmen who will do the detailed design work, drawing, and specifications required to construct a process unit, or an entire refinery. They are supplied with a complete process design, and basic specifications for major mechanical equipment, by specialist groups in Engineering.

The department is called the Drafting Division of the Engineering Department. Actually, we have civil, structural, architectural, mechanical and electrical engineers, as well as draftsmen, checkers, and specification writers. The technical staff numbers 75 men, of whom 20 are registered engineers.

The first work done in the Drafting Division on any process unit is the drawing of the process flow diagram, from sketches made by the process engineer. This drawing shows only basic equipment, flow and controls.

Next, we draw the detailed flow chart. This shows all heaters, vessels, pumps, exchangers, instrument controls, line sizes, etc., and is based on the process design and data supplied by the specialist groups. This is the control diagram for the project and is the point where our Division takes over. All remaining designs, drawings, and specifications are made and issued by us. We design all pressure vessels, piping, foundations, buildings, structures, electric power and lighting circuits, and instrument, and we make all the drawings.

We have four classes of projects:

1. New process units. Here we prepare the flow charts, plot plans, and specifications comprising the basic engineering design for contractors' bids.
2. Offsite facilities, such as tankage,

Note: This article is based on a presentation made by the author to the Effective Drafting Management Institute, held at the University of Wisconsin, October 8, 1959.

MAIN ENTRANCE, Universal Oil Products Administration Building, Des Plaines, Illinois.



from this "board" training is the familiarity thus gained with our standards, files, procedures and company organization.

After the board training, these engineers are gradually worked into design. They are now classed as junior designers. Initially they are given designs made by our senior designers to check, and any designs made by these juniors are checked by senior designers. As they demonstrate ability they are given more responsible work, so that a man's advancement is largely dependent on his own ability to learn and his desire to advance.

Each engineer is evaluated at the end of the first six months and again at the end of the first year. If his progress warrants, he is given a salary increase—if not, he is interviewed to see why he is not advancing. Most of them get an increase in six months, and practically all do at the end of the year. From then on, they are evaluated annually.

It normally requires at least five years with our company for a graduate without previous experience to become a full-fledged designer. Our designers are not mere slide-rule calculators—they must be thoroughly grounded in our standards and engineering practices and must have the ability to lay out an entirely new unit, as well as to make all the calculations involved. Some of our most important design is on the layout—the calculations come later. In short, our designer must be able to do anything involved in the production of complete working drawings and specifications for one of our projects. When he is able to do this his classification is advanced to designer.

Each project which we detail for construction is in charge of one designer. He supervises the plant layout, makes preliminary thermal stress analyses, estimates foundation sizes, and makes all other preliminary calcula-



DRAFTING ROOM (view looking south) at Universal Oil Products Company at Des Plaines, Illinois.

ons required to establish the plant layout. As the job develops he completes the design work on the project with such assistance as may be needed from others. He also assists in checking the detail drawings. It is his job and he must accept the responsibility for it.

Our designers are occasionally sent out into the field for survey work, sometimes for extended assignments, handling alterations and additions to existing plants. Usually draftsmen also are required on these field assignments, in which case the designer normally heads up the squad. He does the design work, supervises the draftsmen, checks their work and handles all liaison between the home office and the customer. These field assignments are valuable training as a supplement to that in the office. They also give the engineer a chance to demonstrate his initiative, supervisory capacity and ability to deal with the customer.

Our designers have ample opportunity for advancement in the department, since their value to us grows with experience. Those with appropriate talents can advance into supervisory positions. Then, too, we are frequently called upon to supply a man for some other department. In such cases we analyze the opportunities and requirements of the new job and commend men accordingly. If the new job is a promotion, the opportunity equal to, or better than, his

present one—i.e., if the man is wanted and he wants the job—we release him. Although we lose many of our best men through these transfers, we are sure the policy is good—it allows others to step up in our department and it furnishes trained, proven men to other departments. What's good for the man is, in the long run, best for the company.

Here is a typical case history of a designer:

A. B. is 30 years old, married and has two children. He graduated in 1951, with a B. S. in Civil Engineering. He joined UOP in June of that year as a draftsman. In September, after only three months in our employ, he was inducted into the armed services where he served until October of 1953. When discharged, he returned to us. He continued his training with us, first as a draftsman, then as a junior designer, graduating to designer status in April of 1958. His present salary is 225 per cent of his starting rate as of June, 1951, and 160 per cent of his rate when he came back to us in October, 1953.

He is presently considered a first-class designer, amply able to handle all assignments as previously outlined. He has had several field assignments, the most important of which was for a period of 10% months as engineer in charge of a field crew of up to 14 men. This job involved extensive alterations to an existing refinery at a

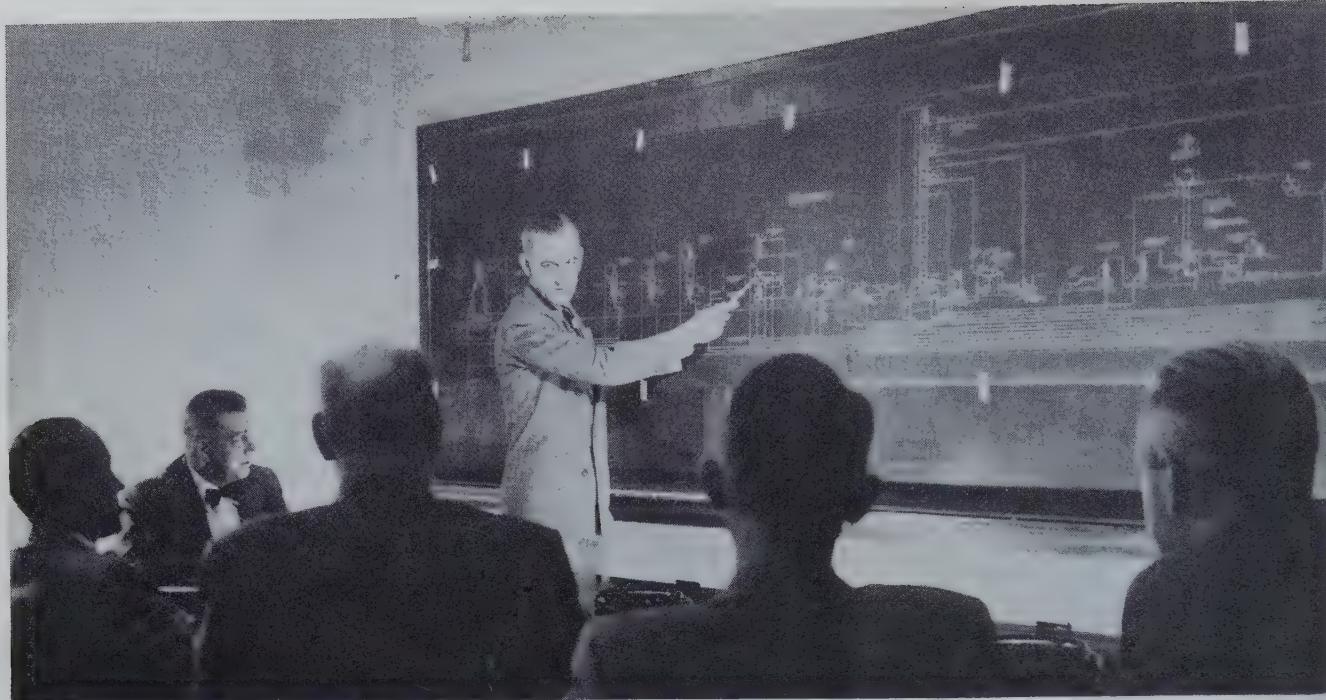
cost exceeding \$7,500,000.

TRAINING OF DRAFTSMEN

Now let us review the training of draftsmen. Normally, these men come to us directly from high school. They are employed first as clerks in our file room and reproduction department. Those who display ambition to get ahead are encouraged to continue their education through correspondence courses or night school. If they want to pursue drafting we advise them on the appropriate courses of study. We supply our own needs by selecting the best of these men, perhaps two or three a year, and putting them into training. In their selection, several factors are considered:

1. Their desire to become draftsmen.
2. Technical courses studied in high school.
3. Correspondence or night school record.
4. Seniority.

Our training program is rather informal. The trainee learns by doing. He is assisted by his supervisor and by the other men as required, but he is basically on his own—the opportunity is there but he must work for it. We hold no instruction classes, nor do we pay his tuition—he must get his schooling on his own. Work in the office and study outside—thus he learns and advances.



FLOW SHEET check provides Engineering Department personnel with essential information for process work.

Each trainee is evaluated every three months. If his progress warrants, he is given a salary increase. If it doesn't, he is interviewed in an attempt to find out why. If a man makes satisfactory progress his training period will cover from two years to 30 months. He then "graduates" to draftsman status and is evaluated again at six months and yet again at one year—thereafter he is evaluated annually.

Draftsmen have ample opportunity to advance. As experience adds to their proficiency, they grow in value and we pay them accordingly. They can look forward to promotion to checker status. Normally they never reach the designer rating, since few of them pursue their outside study far enough to achieve an engineering degree or the equivalent.

Draftsmen are used extensively on field assignments. As previously mentioned, they are often under the supervision of a designer. This field experience is an extremely valuable supplement to the office training.

Here is a typical case history of a draftsman:

C. D. is 38 years old, married and has two children. He graduated from technical high school and spent three years in the armed forces. He was first employed by us as a blueprint clerk in March of 1947. He became a trainee in June of that year. His progress was good and he graduated as a draftsman in February, 1950. He was pro-

moted to checker in June of 1959. His present salary is 442 per cent of his starting rate as blueprint clerk, March, 1947; 380 per cent of his starting rate as trainee draftsman, June, 1947; 222 per cent of his starting rate as draftsman, February, 1950.

He is presently rated as an excellent checker, capable and reliable. He has had several field assignments, one of ten month's duration as a member of a group under an engineer-in-charge. On several smaller jobs where only drafting services were required, he has served without a supervisor, and sometimes alone.

VALUE OF TRAINING

TRAINING improves the engineer or draftsman—increases his value to the company. How does the company recognize this increased value? By salary increases and promotions. As stated earlier, engineers are evaluated at six months, again at one year and annually thereafter. Trainees are evaluated every three months until graduation as draftsmen, then at six months, again at one year and annually thereafter.

The evaluations are made by the supervisors and reviewed by the Chief Draftsman. They are also available for review by the Manager of the Engineering Department, the Vice-President in charge of Engineering and the Personnel Director.

Evaluations are based on the following which are not necessarily listed in order of importance:

1. Attitude and cooperation.
2. Quality of work.
3. Quantity of work.
4. Ability to learn and improve.
5. Initiative and creativeness.
6. Judgment.
7. Punctuality and attendance.

These evaluations are the basis for promotions and salary increases.

The above methods of training have demonstrated their value, over the years, to our employees and to the company. Other organizations may find that the procedures need some adjustment to suit their own needs. In general, however, we are convinced that the basic philosophy is sound—that qualified men can be developed rapidly if given the opportunity to learn, proper recognition of accomplishment and the incentive of advancement.

The Author

M. F. PERKINS, a registered engineer, is Chief Draftsman at Universal Oil Products Co., Des Plaines, Ill. He joined UOP in 1934, and functioned as Draftsman, Checker, Designer, Supervisor and Assistant Chief Draftsman, before succeeding to his present position in 1951.

Between the Lines

The cooperative responsibilities of engineers and draftsmen are examined by a senior designer

by Robert Howison

AS AN ENGINEER, you may think, "A draftsman is a draftsman. So what?" Or you may never even give it a thought. As a design draftsman, however, I feel that in our world today the draftsman is an important part of society.

He is the one who transforms the engineer's rough sketches into polished layouts. He is the one who translates words into details. He is the one who gives a black-and-white organization to the crazy-quilt pattern of thought. He is the one who puts life into the stillborn idea. He is the engineer's link between idea and reality.

Now that I have inflated the ego of all the draftsmen in the house, I am going to proceed to puncture it. There has not been a draftsman since Leonardo DaVinci who was or is indispensable and there never will be. Were any one of us to drop dead, the company would not lose one minute of production. Next to our family, the insurance company would be the chief mourner at our funeral. I am not saying that any one of us would not be missed because, we all know something of the company's problems and methods which would be missed, but someone else would step into our spot and eventually fill the void.

What I want to say is simply this: that although no one of us is indispensable, draftsmen as a group have

made themselves a vital part in our culture. We may not be drive-gears but certainly we are cogs in a system which is just as much out of action with a missing third or fourth pinion as it is with a missing main drive-gear.

EVOLVING FUCTION

TO PUT IT another way, we are a crutch to the engineer upon which he has come to depend more and more. The engineer has not the time, the willingness, or the ability any more to do the work which we perform. More and more of the things which engineers used to do for themselves in years gone by are now falling upon the shoulders of a draftsman.

I can remember hearing about how engineers used to conceive an idea, make their own layouts and details, build their own models, design their own tools and dies, and supervise production. This has not been beyond the memory of some of you. But, can you just imagine today's engineer saddled with all this? Can't you imagine how long it would be between model changes or how few new products would appear on the market? How many engineers would

Editor's Note: This article is based on a paper recently presented by the author to an audience of product engineers, project engineers, technicians, designers, and engineering supervisors at King-Seeley Corp., Ann Arbor, Mich.

go into another profession were they faced with this future?

Now, perhaps, you too have some idea of what I mean when I say that the draftsman is the link between idea and reality and perhaps you can now realize a little of how I feel about draftsmen.

Realizing this, let us examine more closely the various facets of a draftsman's job and in so doing find out his shortcomings and his abilities so that you may take better advantage of his talents, and he of yours. In order that we pull with each other instead of against each other we must know what is going on around us and, perhaps, I can add a small bit to our knowledge.

Being rather limited in my experiences with other companies, I shall have to base my opinions upon what I have observed in a few years here at King-Seeley. I cannot very well speak for the rest of the draftsmen since we are individuals, and think and act differently, upon our thoughts. However, I know that at least some of what I say is of general interest and concern to all of the draftsmen.

Rather than indulge in a course on the mechanics of drafting with which you must all be familiar, or in a discourse upon simplified drafting techniques about which so much is being said nowadays, or about the making of readable sketches, or about the pros and cons of the metric system,



VIEW OF DRAFTING ROOM at King-Seeley Corporation, Ann Arbor, Michigan.

I should like to go "between the lines" and make some comments. In order to do this, I must tell you some of the things a draftsman is and some of the things he is not. I must further go into what you may expect of a draftsman and what I think he may reasonably expect of you. In developing these themes I hope to leave you with a couple of thoughts which may make all of our jobs pleasanter and more constructive and productive.

WHAT A DRAFTSMAN IS

FIRST OF ALL you may wonder what possesses one to become a draftsman. I suppose that there are as many reasons as there are draftsmen. Some may have seen the ads in *Popular Mechanics* which said, "Be a Draftsman - Earn Big Money." Others may have thought to use this as a stepping stone to the engineering fields. Still, the next fellow may not have wanted to get his hands dirty in the shop. Whatever the reason, we are here so, I guess that is all that really matters.

If you were to analyze my job, you would find that it takes but a fraction of a second to draw a line a couple of inches long, and that it takes only a few minutes to set down a whole series of lines. Evidently then, there must be more to drafting than the mere matter of drawing straight lines and circles.

You could give my youngest daughter a pencil, paper, straight-edge, and compass and in short order you would have a whole page full

of lines, shapes, and blobs. You might just possibly wind up with an abstract art form but I don't imagine you would want to put it into production. The thing my daughter lacks at the age of four is the ability to think much beyond squiggles and blobs.

A draftsman, then, is a thinking man and I don't mean that he has to smoke Viceroy's to prove it! He has to be able to come to logical and orderly conclusions from the facts he has at hand and from the odds and ends of information he has squirreled away in his head. He has to be able to recall to mind the things he has seen, or used, or heard of, or read about in the past so that he may use them in today's design. I don't know that his thoughts have to be upon a world-shaking plane; still his job is such that it requires a great deal of thoughtful attention. His job, certainly, is not the type that is so routine he can let his mind wander for very much of the time. I know you must think sometimes that on the basis of some of our more stupid mistakes we must have had our minds in neutral, but I assure you that this is not quite standard procedure.

A draftsman must have patience in large quantities. He must be able to sit day after day for long weary hours doing the detail work necessary to give others a clear idea of what he and the engineer have in mind.

Speaking for myself, I find it interesting and stimulating to work up a layout of a new design concept.

When that is done, I would like to drop it like yesterday's newspaper and go on to another design, but obviously, this cannot always be the case. There is the necessity for making details, sub-assemblies, and assemblies with all their pertinent dimensions and specifications to enable a tool designer, tool-maker, purchasing agent, production worker, inspector, and vendor to produce a part that will function properly.

And—this business of revising the second revision of the fourth attempt at a design; there's the rub. I am sure the devil must have thought of this trial after he had gotten through with poor old Job. It is here to stay and we should get used to the idea that we probably won't ever come up with a perfect design on the first attempt but even knowing this it still is a trial to one's patience at times.

WORKING IMAGINATION

IMAGINATION plays a large role in a draftsman's life. You must think at times that it is a pretty wild imagination; but, I suppose, everybody is entitled to a flight of fancy now and then. Without imagination, though, a draftsman might just as well turn in his time and trade his tools for a pick and shovel.

He must be able to take his own or somebody else's ideas and change them from words or sketches into lines on his vellum; and to be able to do this he has to imagine or visualize in his mind's eye what it is that he is going to delineate. He can't just

willy-nilly put down lines hoping something good will come of it.

I like to think of designing as though it were a jig-saw puzzle in three dimensions with some of the pieces missing. Sometimes, too, the fourth dimension of time is thrown in to compound the confusion.

These jig-saw pieces—or known components, if you please—may often be put together in more than one way and often you may be able to put several of them together very nicely only to find that another important piece is way out in left field with no place for it to fit in. So—you disassemble and rearrange. This might happen several times and then the fourth dimension of time becomes an urgent problem. It often happens, after you have started to assemble the design jig-saw, that new pieces are put into the game and new limitations imposed. This cannot be considered as not being according to the rules or constructed as an unfair labor practice but you can see that it does take a degree of imagination to accept these situations and fit them into the picture.

The draftsman is also a skilled craftsman who has acquired his skills with years of practice. It does not just happen overnight that he receives an ability to handle hundreds of dimensions and part numbers in his head, nor does he learn to place views and cut sections to best show the intent of the design by taking a course in Drawing I and II.

The ability to properly dimension a drawing with all the necessary dimensions without duplications is something he has to practice and struggle with for more than two or three weeks and is something that cannot be entirely learned from a book. What constitutes good or bad shop practice he finds out in bits and dabs from talking with tool designers, and model makers, and by sifting all the other chaff that comes along.

It takes the practice that comes from making hundreds of drawings to be able to make the lines stand out sharp and clear and to be able to achieve a contrast between the outlines of the part and the dimension lines. We draftsmen may never win an art award but there is still a little

bit of satisfaction to be gained from looking at a drawing of a difficult piece after you have finished and realizing that you made it without anybody guiding your pencil and that it looks pretty doggone good. There are aspects of the craft which some of us will never be able to master and yet we know that what we have, nobody can take away and few others can do as well. Someday, the mechanical arts may gain recognition along with the fine arts but until then, we can still take a craftsman's pride in our work.

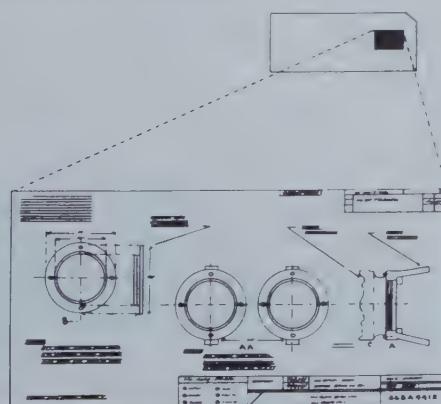
WHAT A DRAFTMAN IS NOT

NOW THAT we have had a look at some of the things a draftsman, let us take a peek at what he is not. In order to know what some of his negative characteristics are, we must bear in mind that he is only human. He puts his pants on one leg at a time and he smells bad if he does not bathe.

Very few draftsmen are graduate engineers. A number of them may have had a year or two of college

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while others picked up the fundamentals of their craft in night school sessions or in trade schools. Some have simply learned by doing. I realize that some areas of design dictate that the draftsman have an engineering degree to fulfill the responsibilities of the job, but by and large it is not the type of work that attracts a graduate engineer and, indeed, it is not often necessary to be an engineer.

Knowing that the draftsman does not have an engineering education will, therefore, have some influence on the manner in which you will explain and describe your ideas to him. This is not to imply that he is not an intelligent person but merely to suggest that he is, perhaps, limited and hindered along some lines which to you may seem so simple as not to require a second thought.

And speaking of thoughts, most draftsmen are not clairvoyant. The "Great Dunninger" may be able to read people's minds but, as a group I would say that draftsmen are no better off than the man in the street. If a draftsman is acquainted with the engineer with whom he is working, there may be rapport from which he can make inferences out of fragments of ideas or thumbnail sketches, but so often these inferences can lead to false assumptions.

The draftsman is also not capable of turning out two days of work in an eight-hour day. There are times when a particular job can be speeded up and there are times when it cannot. Sometimes a drafting job can be rather sketchy as for instance when it may be going into our own model room. There it is only a matter of running upstairs for the designer or engineer if the modelmaker gets stuck for an answer, but I would hesitate to make sketchy details for the sake of saving drafting time if the work is to be done outside of our own plant.

There is too much at stake to be hasty in preparing drawings. Time may be lost. A job may be shut down, or a die rebuilt because too much emphasis was placed on getting drawings made and out of our department. To sacrifice carefulness for the sake of a few hours is a risk that should never be taken without weighing carefully all that is involved. The very nature of drafting demands that we go slowly at times. Certainly, most draftsmen can be called on for an

extra effort at times when it is necessary, but do not rely on making an unrealistic deadline too often. They have a way of coming back to haunt us.

Let me say, also, that a draftsman cannot be expected to supply the engineering groundwork upon which to build a design. Granted that a draftsman can make a contribution occasionally, he must still have good solid engineering to back him up. He can fumble away days or hours trying his best and still fail to get started in the right direction if he has no guides to help him. A first-class draftsman may be only a third- or fourth-string substitute engineer.

WHAT TO EXPECT OF DRAFTSMEN

A LONG ABOUT NOW is the time to find out what to expect of a draftsman and what he expects of you. I can only presume to state what you expect of us but I will try, and if I do not succeed perhaps you will straighten me out afterwards so that I will know better the next time.

First of all, you must expect that we will give as much thoughtful attention to the project at hand as you have. Without thought and attention on our part, your ideas are no better than no ideas at all.

Certainly, after you have done your best, then we must be careful that your work is not in vain because of us. There should always be an awareness by us that what we put on paper is going to be executed in steel or plastic or die cast, and that the way in which we express ourselves may mean the difference between a good or bad part or assembly. We should be always striving for efficient low-cost design which can be easily and swiftly assembled. We should try for simplicity rather than the spectacular in design. Most often the simplest way is the best way and the design with the fewest and least complicated parts is the design with the fewest chances for error and breakdown.

Second, you have the right to expect that, after you have gone over your ideas with a draftsman and briefed him on the workings, he will then take over and with a minimum of your time and attention carry through to a conclusion. The draftsman should be able to handle his part of the job without you having to wet-nurse him along. If he cannot

or does not, then either he is not doing his job or you must re-examine to see if the explanations which you gave him were correct and adequate.

Again, it is expected of a draftsman that he do his work with a minimum of wasted time and a maximum of exactitude and clarity. Every drawing he prepares should show the form and intent and scope of the part or assembly. Unless this is the case, you can expect your phone to be ringing and the line foreman and purchasing agent to be camped at your desk. There should be no room for guesswork as to why this view looks the way it does and whether this figure is a "three" or a "five" or what the length of this widge is. You should expect a draftsman, when he is in doubt, to call upon you; for if he is in doubt then you may be certain that the same doubt will exist all along the line.

You should expect a draftsman to point out errors or oversights which he finds in your work. I don't mean that he is to be vindictive in this, but rather that I am sure you would like it best to have these errors pointed out while they are easily correctable. Perhaps you look on the draftsman as a drag or a wet blanket but better he than a foreman or an inspector. This way your embarrassments are known to the fewest number of people.

All the things I have mentioned, I am sure we try to do. The fact is that trying is not always enough. We often fall far short of the standards I have set. We forget a dimension now and then and I have at least a bushel of missing arrowheads stashed away that somehow got left off. Occasionally we forget a section or revolve a view in the wrong direction. I know, too, that every time a modelmaker starts to assemble one of my projects, I keep wondering where he is going to find an interference which I have overlooked. I know, too, of the many fine resolutions I have made to do better and not be trapped in the same mistake twice and, I know of how quickly I have forgotten my fine resolutions. Perhaps, this is why we are provided with lots of erasers.

WHAT TO EXPECT OF ENGINEERS

NOW THEN, this is where the street gets to be a two-way

chorofare. The draftsman expects something of you, too, and I will try my best to enumerate as clearly as I can what it is that we expect.

The most important thing you can do for us is to give us information and lots of it. Our designs can be no better than the information we have about what we are doing. If you have forgotten to tell us something that you want or expect then we most likely will leave it out.

It has long been my opinion that a draftsman should be included while an idea is in the planning stage. I know that some people may think he is not really necessary until the idea has been thrashed out and jelled, but I still feel that the thinking which you have gone through would be of inestimable value to him.

So often the things which he considers important are never mentioned to him because you do not realize their worth to him. It is just possible that he too might make a contribution to the idea while it is germinating. If he can get his information firsthand rather than having to get it from a second source or possibly several sources, he will, in the long run, save many times the few hours he may

have been away from his board listening in on conference.

Do not hesitate to throw in as much background as you possibly can. If you feel that he is not grasping what you are saying, then make another stab at it from another tack. Maybe, you might be wise to conduct your own little course in electricity, or chemistry, or mechanics. The review will not hurt the draftsman any and it might open up a new pattern of thought for you.

A bit of a statement on your part as to what the potentials and hopes of your project are might be the spark that kindles the draftsman's enthusiasm for your job and lifts it in his opinion from the humdrum of routine into something really worthwhile working on. Please, realize that a project tackled with enthusiasm has forty-leven times the chance for success as one approached with an "Oh what good is it?" attitude.

The time element is a large factor in a draftsman's life. I suspect we wonder as much about the way in which deadlines are set as we wonder about anything else. It would not surprise me a bit to have someone come out of the hat with a slip saying

seven-and-one-eighth instead of a deadline date. I know that you are too often left without a voice in the matter of when a job must go into the model room or when it must be completed for cost estimating, but when you have a voice, exercise it and be as generous with time as is possible.

An extra day or two may be the difference between a good design or mediocrity. I shall get paid for forty hours per week whether I am working on job "X" or "Y", or "Z". So, if job "X" belongs to you, then it is to your interest to see that it gets its full share of drafting time. You must think that we spend an unseemly lot of time on details and minutia, but if we do not then nobody will, and eventually it gets back to us anyhow.

ATTENTION TO PROJECT

IF I have heard it said once, I have heard it said at least a hundred times—"When you want an engineer he cannot be found and when you do not want him he is hanging over your shoulder." It probably only seems that way, but it does point up the fact that occasionally we need

(Continued on page 36)

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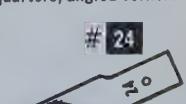
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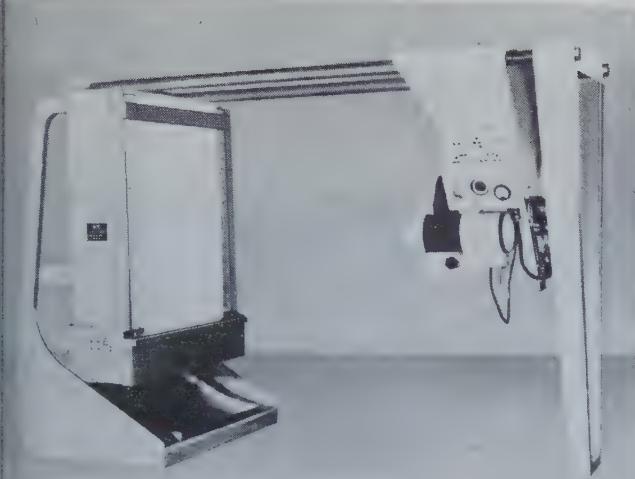
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All of this is accomplished almost automatically. Film is loaded manually onto a holder, the exposure time is set, and a push of the button does the rest. It takes 40 seconds to produce a finished print. A pre-set regulator permits the equipment to make up to 19 prints automatically from a single negative.

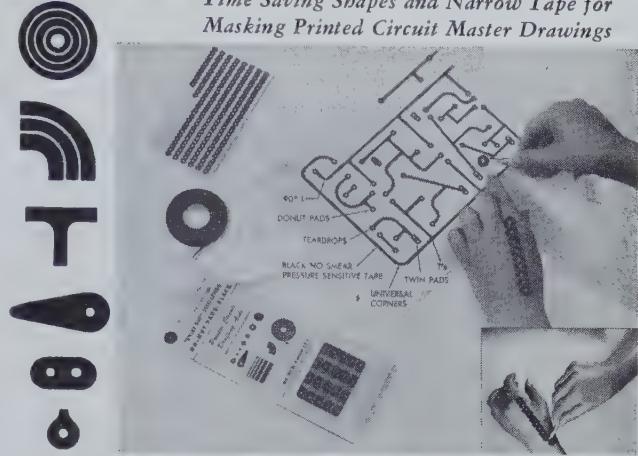
The equipment will handle 35mm, 70mm, and 105mm negatives, producing sharp, black-line positives on a white background. Projection size is varied by moving the projector head on an overhead track to print any dimension ranging from 8½ by 11 inches up to 34 by 48 inches. The use of a high intensity point source light, requiring short-exposure of the sensitized paper, is said to be a major factor in both the high-speed printing cycle, and the sharpness of the black-line print.

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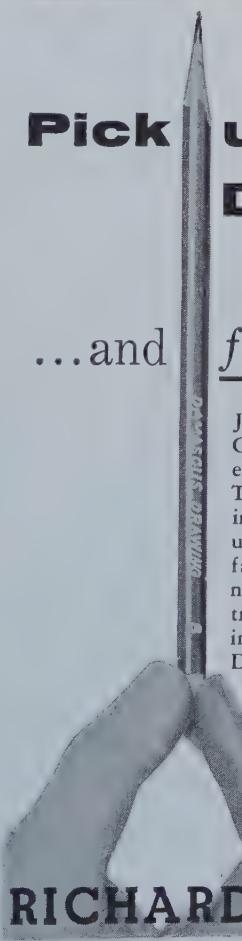
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(Continued from page 8)

sive and adequate treatment of graphic representation.

Men like Anthony, the Reid Brothers, Jamison, Fellows, and French, published books on drawing which explored the field as never before, and which adequately covered the subject in all its phases. Along with this development in drawing literature, books other than texts on "mechanical drawing" appeared, and the literature of graphics began to make its appearance in books covering the fields of structural, architectural, topographic, machine drawing, and later an even newer branch covering the subject of the technique of presenting statistical and technical data in graphical form.

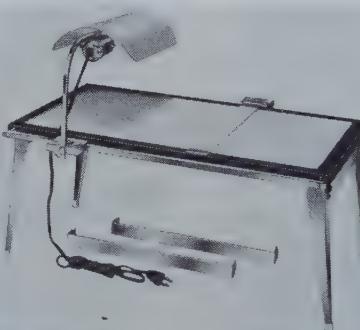
For a number of years, both teachers and practitioners had been feeling mild dissatisfaction with the inherited and misleading name *mechanical drawing*, and with the more evident divisions of graphics into specialized branches it was inevitable that new names should appear. Professor Anthony's designation of *graphics* and Professor French's name of *engineering drawing* were both attempts—and successful attempts—to establish a fact known but never properly presented: that drawing of whatever kind, is a *graphic language*, and to each of these pioneer leaders the profession owes a great acknowledgement.

No sooner had the idea of a graphic language been established, than dissatisfaction and disapproval of the lack of standards, the absence of uniformity, and the freedom with which ideas were conventionalized began to be published, and at once received endorsement. Like the weather, a great deal was said about it, and nothing at all was done, until under the impetus of the *simplified practice* movement, the American Standards Association, with the Society for the Promotion of Engineering Education and the American Society of Mechanical Engineers as sponsors, organized a committee to establish standards for drafting and to bring such standards into agreement. This committee has been at work now since 1926, and its continuing recommendations for uniformity will, in the end, make drawing what it should be—a truly graphic language.

New Products

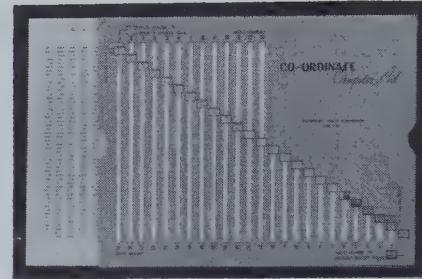
Dry Process Whiteprinter

Automatic printing of drawings up to 42 inches (with oversize printing and developing to 45-inch width), at a 60 foot-per-minute rate, may be accomplished with the Lancer Special Dry Process Whiteprinter. Produced by Copymation, Inc., Chicago 45, Ill. (formerly Peck & Harvey Mfg. Co.), the machine has a 4,000-watt, jacketed quartz lamp, providing 80 watts-per-inch of light. Designed for operating efficiency, the machine has a one-step feed; printing, copy separation, dry development, print delivery and print stacking are accomplished automatically. A self-priming pump automatically refills machine developer from poly jug or remote jug. All interior parts of the machine can be reached easily for cleaning and routine check up.



Scope-Light Table

An all-purpose scope, said to provide the proper surface and light for drawing, lettering, ruling and writing on stencils, spirit and gelatin masters and paper offset plates, has been introduced by The Heyer Corp., 1850 S. Kostner Ave., Chicago, Ill. It can also be used as a light table for retouching negatives, etc. Called SuperScope, the portable unit has a 10 by 18½ - inch ceramic-coated diffusing glass. An adjustable light can be placed—and locked—in any position over or under the glass surface. Clear plastics sliding, locking T-square, and spring steel clamps hold stencil or other master copy in place.



Co-ordinate Reference

Drafting computer said to insure the accurate layout of bolt hole patterns, electrical connector pin locations, and other drafting jobs requiring circular point patterns, is offered by Patterson-Harrison Instruments, P.O. Box 784, Everman, Texas. It provides a reference for angular measurements, chord lengths, hole patterns, tangents, polygons, etc. Two simple steps determine the X and Y dimensions of 3 to 50 equidistant points on a circular. Called the Co-ordinate Computer Aid, the device is said to cut both drafting time and error.

Protractor-T-Square

A device used in the same manner as any ordinary double-headed square, but possessing protractors on the two heads, is manufactured by The O. A. Olson Mfg. Co., 712 Tenth St., Ames, Iowa. This protractor may be used to measure angles as well as to construct them. A simple swivel joint with locking device is provided.

Microfilm Processing Solution

One-step processing solution for microfilm negatives of all types, and a complete family of chemicals and accessories to go with it, has been announced by Cormac Chemical Corp., 80 Fifth Ave., New York 11, N. Y. Called UNIBATH CC-7, the one-step solution is said to provide a super fine-grain processing of microfilm within 4 minutes, with washing time to archival quality reduced to 2½ minutes.

(For additional information regarding the new products described here, contact the manufacturer directly. Complete addresses are included.)

New Literature

Metal Filing Cabinets and Furniture are the subject of a condensed catalog (AD-2475-59) offered by Art-Metal Construction Co., Jamestown, N. Y. Planfiles for vertical filing of engineering drawings, maps and blueprints, as well as office "modulars" (which fit together in flexible combinations) are described and illustrated. A wide variation of office desks, chairs, library bookshelf units, and other filing cabinets are also included.

Drafting Machines for Horizontal Boards, a folder (No. 5955), will interest users of fixed drafting tables. Both standard and universal protractor heads are described. This folder may be obtained from Isis Incorporated, Box 1062, York, Penna., distributors in the U. S. for equipment manufactured by Schmidt & Haensch, Precision Mechanics and Optics, West Germany.

Tracing Vellums, a 5" by 8" notebook of nine vellum sample sheets, together with their catalog designations, in roll, sheet, or pad sizes, may be requested from Frederick Post Co., 3650 North Avondale Ave., Chicago 18, Ill.

Swing-Arm Lamps Brochure, containing detailed information on fluorescent, counter-balanced lamps for drafting tables and desks, may be requested from Swing-O-Lite, 13 Moonachie Road, Hackensack, N. J.

Drafting Training Film, The Concept and Principles of Functional Drafting, a 16mm, 20-minute sound motion picture that graphically portrays the time-saving techniques of functional drafting, may be obtained on either a rental or a purchase basis, from Industrial Education Film Library, 3 Palmer Square, Princeton, N. J. At the request of leading organizations, Industrial Education Institute made studies to determine what information is needed to indoctrinate the new man as well as the experienced draftsman and designer in the principles of functional drafting; the film, reviewed for accuracy and correctness by technical authorities, is the result.

Technical Information Systems, Report No. 2, *Nonconventional Technical Information Systems in Current Use*, (NSF-59-49), has been prepared by the Office of Science Information Service, National Science Foundation. Each report consists of descriptions of technical information systems currently in operation which embody new principles for the organization of subject matter, or employ automatic equipment for storage and search. The Report is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at a cost of 30 cents.

Printed Circuit Reference Chart, including all of the pre-cut shapes and sizes of pressure sensitive drafting aids required to make paste-up printed circuits drawings, conforming to military specifications (plus some non-military configurations) will be mailed free to any draftsman requesting a copy from BY-BUK Co., 4314 W. Pico Blvd., Los Angeles 19, Calif.

(Copies of the literature reviewed can be obtained directly from the manufacturer or publisher. Complete addresses are included.)



Camera-Projector Bulletin titled *Big News In Miniaturization*, No. 11-59 (50729), is offered by Keuffel & Esser Co., Third & Adams Streets, Hoboken, N. J. The bulletin highlights K&E's new Micro-Master 105/35mm Camera-Projector which will handle both 35mm and 105mm film.

Portable Drafting Equipment Bulletin, describing the Ames Draft-Pak, is offered by The O. A. Olson Mfg. Co., 712 Tenth St., Ames, Iowa. The self-contained unit will interest students and others who do work in the field or at home. It includes board, parallel blade and storage compartment.

Lighting Brochure (No. 328-955), *Presenting Better Seeing Systems For Better Office Work* by W. S. Fisher, also contains lighting information relating to drafting departments. The 24-page, illustrated brochure may be requested from General Electric Co., Lamp Division, Nela Park, Cleveland 12, Ohio.

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- New, compact column construction for standing or sitting.
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- Perfectly balanced; effortless, infinitely variable adjustments.

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UNITECH CORPORATION 50 Colfax Ave., Clifton, N. J.

A complete line for draftsmen

Between the Lines

(Continued from page 31)

help that only you can give us. I know that I hate to be running you down and pestering you a dozen times a day but I do not know how to avoid it.

It seems to me, too, that if a job of yours is on the board it might be nice to check in and say "hello" to the draftsman once or twice during the day. Who knows, maybe he will even buy you a cup of coffee?

Then there is the matter of criticism. We welcome it especially in the earlier design stages when things have not progressed to a point where it becomes difficult to make a change. I know that it is always easier to second-guess than it is to conceive for the first-time, but if the second-guessing can be done while the design is progressing rather than after it is finished, the results are liable to be better and pleasanter. It could even be wise to consult with tooling or purchasing more than has been done in the past.

JOINT RESPONSIBILITIES

ALL THAT I have said thus far can be pretty much accepted at

face value. However, there are some areas which are not so black and white or so clearly seen. What I am referring to is that once in a while the draftsman finds that something is not working out the way it should or in the manner that he expected.

Just when does one decide that things have gone far enough in that direction and that a re-appraisal is necessary? Or maybe, even that the job should be stopped or dropped in favor of something better? To whom does this responsibility belong? Is there the possibility, also, that the old proverb about "too many cooks" applies to drafting as well as to the making of a fine broth? Any or all of these questions might apply to any particular design and the answer might be different with each particular case.

Just briefly, I would like to touch on the idea of a design follow-up. How often after some new design goes into production do you appraise the designer of the problems that the line is experiencing or how well things are working out? And when you make a radical change after production begins, do you think to tell the original designer of what you are

doing and why? He is interested, you know. The time and effort he has put into something cannot be shrugged off too lightly. Once in a while, too, it seems to me that a guided tour of the line with explanations of what is going on and why, would help the draftsman in future designs.

A FINAL WORD

MY USE or mis-use of the English language may have left you in the dark about some of the points that I was trying to make but I think I can do a good job of summing up in one sentence. It goes like this. An understanding of what goes on "between the lines" and a realization that the draftsman is the engineer's link between idea and reality will go a long long way in using the draftsman and his abilities to the best advantage.

The Author

ROBERT HOWISON is a senior designer in the Engineering Department of King-Seeley Division of King-Seeley Corp., Ann Arbor, Michigan.

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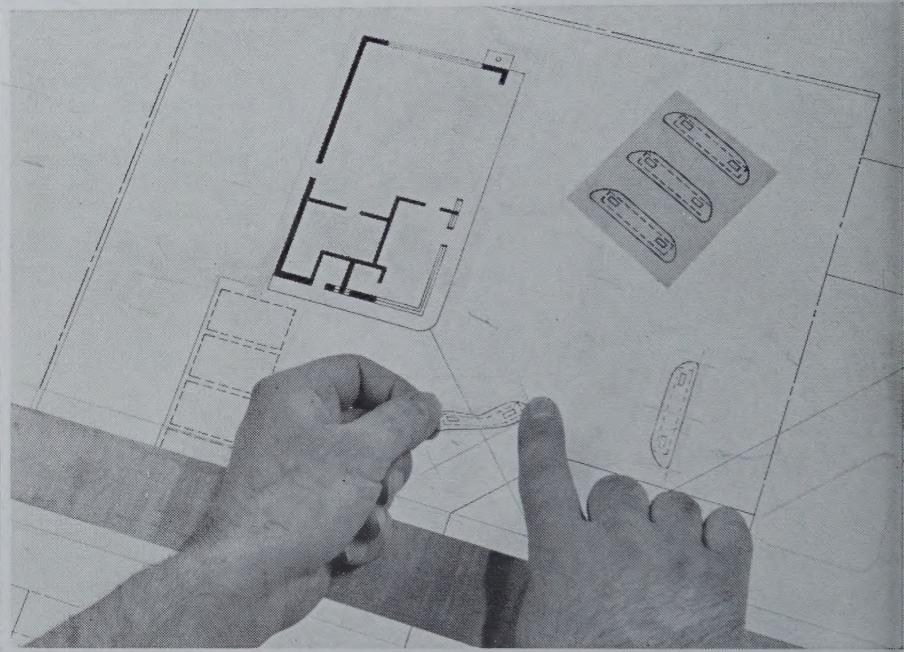
Have you ever thought what would happen if your company's original drawings were lost or damaged? How much trouble and expense would be involved to replace them? Many companies are adopting a simple "insurance" program to meet just such a problem . . . a program which requires neither expensive new equipment or radical adjustments of established procedures. The program consists of two parts. First, recognizing the cost of *any* drafting medium is always an infinitesimal part of the investment in a finished drawing, the companies standardize on the drafting medium which affords their original drawings maximum life. Second, they institute the policy that original drawings must be used only as *masters*, that all printmaking must be done from *duplicate originals* of the masters.

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Drafting-Printmaking Booklet reports new techniques for solving engineering and production problems

This new 36 page booklet describes a wide variety of engineering and production problems that have been solved with advance techniques in drafting and printmaking pioneered by Dietzgen. The concise, problem-solution approach suggests ways in which you may improve the effi-

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